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TASK ACCOMPLISHMENT IN AN AIR FORCE MAINTENANCE ENVIRONMENT.(U)
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TASK ACCOMPLISHMENT IN AN AIR FORCE
MAINTENANCE ENVIRONMENT

by

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ABSTRACT

This research investigated the impact of environmental (in the organizational sense) distractions, and the resulting coping behaviors, on maintenance performance. Prior research focused on investigating performance out of context, that is, in controlled environments. Maintenance personnel must not only achieve technical task completion, they must also contend with an environment that provides many distractions that may impede that task performance.

This investigator spent one week at three different bases, one MAC, one SAC, and one TAC. He spent 107 hours observing eight different crew chiefs and nine different specialists. Because the study was designed as exploratory research the methodology precludes generalizing the results to the Air Force maintenance population. However, the methodological and conceptual problems encountered in the exploratory research are resolvable and a viable research plan to conduct a representative study is presented.

The phenomenological data support the original concept and suggest that the relationship between performance and contextual variables is even more important to productivity than originally assumed. Those maintenance people observed spent fifty percent, or better, of their maintenance shift coping with environmental distractions that for the most part hindered task accomplishment. At the same time, study results suggest that there are multiple Air Force maintenance environments, rather than a monolithic maintenance environment, but the maintenance system assumes a monolithic environment.

The possible payoff for management is that significant increases in maintenance performance might be realized by controlling environmental distractions. The assumption that the individual maintenance person controls the majority of the variance in the productivity equation is challenged and it is suggested that the majority of the variance is dominated by situational variables.

BIOGRAPHICAL SKETCH

Dr. William D. Kane, Jr., is an Assistant Professor of Management and has been at Western Carolina University since August 1976. Dr. Kane retired from the Air Force after twenty years service, primarily in avionics maintenance, and earned his Ph.D. from Cornell University in Organizational Behavior. While in the Air Force, he earned a Bachelor's Degree in History and a Master's Degree in Systems Management. He has taught management, personnel, business policy, organizational behavior and organization theory courses, both graduate and undergraduate, since coming to Western Carolina University. Dr. Kane is active within the university and serves on a number of appointed and elected committees at the departmental, school, and university level. He has been active in regional service and has consulted with a number of firms in the area. Dr. Kane was a Summer Faculty Research Fellow with the AFHRL/LRLM at Wright-Patterson Air Force Base, Ohio in the summer of 1979 and conducted a feasibility study on maintenance readiness in the summer of 1980.

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I. INTRODUCTION

The objective of this research was to conceptually determine whether or not an individual technician's response to contextual variables is a significant component, along with task accomplishment, of performance and/or productivity. In research conducted for AFHRL/LRLM as a Summer Faculty Research Fellow (Kane, 1979) I concluded that previous investigations had totally ignored contextual variables when researching performance. The investigators purposefully strove to control contextual variables using a laboratory or semi-controlled environment focused completely on the technological components of the task. However, when technicians function in a shop, flightline, or silo environment, contextual variables may play a substantial role in total task completion. Noise, weather, and lighting conditions are recognized as impacting on performance, but no research exists on how technicians cope with or adapt to such variables as: no crew chief is present when the technician arrives at aircraft; the aircraft is too crowded with other simultaneously scheduled technicians; transportation to the job site is inadequate; the technician has the wrong technical data; a part is needed from supply; a malfunction is recognized which is not part of the original discrepancy; the power unit runs out of fuel; the technician is not quite sure how to proceed with the task; frequency of supervisory visits to the task site; and the test equipment does not function properly. What should be included as contextual variables of the maintenance environment is a research question, but the above mentioned incidents and how technicians cope with or respond to them are pertinent to performance; yet no research currently exists which investigates the impact of these contextual variables on performance. It may be that a technician's coping with environmental distractions is as important to performance as technical task accomplishment.

To investigate the hypothetical relationships I spent 107 hours on three different bases directly observing in their work environment eight crew chiefs and nine specialists. The suspected relationships are there. They are more important to productivity than originally thought, but the research problem is far more complex than anticipated. The aircraft maintenance environment is not a monolithic one but is instead a multiplicity of task environments. As the missions of MAC, SAC, and TAC differ, so do their maintenance environments. The environment of the specialists working in a quiet shop is markedly different from the environment of the same specialist working on a noisy, busy flightline. Crew chiefs do not understand the specialists' world, the specialists do not understand the crew chiefs' world and noone has an understanding of how the various environments shape the behaviors of those who work in them. One of the outcomes of this research is that individuals themselves are not aware of the impact on their behavior of environmental variables. What else has emerged from this research is reinforcement for the idea that maintenance technicians are exposed to an almost infinite queue of environmental demands from which they must select, using some kind of a selection system, and available time (or other resources) constrains the number of events they can attend to. Therefore, they select some, neglect others and the select/neglect activity is not necessarily according to conventional wisdom (i.e. maintenance policy). While this line of research is far from complete it does indicate some interesting ways to seek increased productivity.

This piece of research was proposed as a conceptual study and as such cannot be generalized to the maintenance population in its current form. Site selection was not random, subject selection was not random, the number of subjects is quite small, sophisticated statistical techniques cannot be used, and there was only one

observer. However, the research is a success in that it has accomplished the preliminary experimental work and clarifies how an expanded effort could be carried out. It must be noted that one of the major constraints on the methodology (i.e. sample size and number of observers) was the funding parameters of an Air Force Office of Scientific Research minigrant.

II. REVIEW OF THE LITERATURE

A relatively new area of study of human behavior and the environment is behavioral ecology. The ecological perspective reflects interrelationships and interdependencies within behavior-organism-environment systems. Behavioral ecology is an underdeveloped branch of ecological science and focuses on the means by which persons carry out transactions with their habitats. Being an integral part of an ecological system involves behavior and the relationships between that behavior and the environment with which it interacts. The following is a brief discussion of the ecological perspective as it relates to this research.

Willems(1973) defines behavioral ecology as a general orientation or viewpoint that leads one to view behavior, behavior change, and research upon them in certain distinctive ways. Behavior is a property of ecological systems rather than an attribute of the individual. He believes that day-to-day and moment-by-moment behavioral criteria, as well as indicators or expressions of enjoyment, comfort, and satisfaction, can be very misleading indicators of how functional an environment is. He believes that, at many levels of analysis, behavior is implicated in very complex organism-environment-behavior systems. Willems (1973) interprets Benarde (1970) to say that "The significant feature is that the social, physical and biological components function as an integrated system, and any tampering with any part of the system will affect each of the other parts and alter the whole." Willems(1973) goes on to say that questions of large and unintended effects within interpersonal and environmental contexts over long periods of time beg for evaluation and research in order to understand the effects of both small and large intrusions into person-system relationships. The widening awareness of the ecological perspective suggests the need to know more about the

principles that govern and characterize the systems in which people live and work and the change efforts directed toward those systems. Willems (1973) thinks that a clear need exists for a great deal more basic research and theoretical development that takes account of the ecological, system-like principles that permeate the phenomena of behavior and environment. He further states the need for a scientific basis which must be ecological in its perspective on behavior.

The methodological orientation of behavioral ecology is largely naturalistic because it is not defined by any particular technique. The ecologist advocates dependence on direct, sustained, naturalistic observations of human behavior and less on shortcut methods based upon verbal expression and the handiest investigative location. The ecological perspective tends to be highly eclectic as the ecologist borrows and lends concepts, methods, and hypotheses freely because he believes that the sciences of behavior thrive on a mosaic of approaches. Behavior is embedded in and relates to phenomena at many levels, which themselves form hierarchies of embedded systems. The ecologist focuses on larger, setting-sized behavior episodes and concerns himself with the distribution of phenomena in nature, upon the range, intensity and frequency of behavior in the everyday environment. James and Jones (1976) agree with Willems (1973) and issue a strong plea for organizational research which encompasses both individual and situational characteristics as anticedent causes of individual behavior and attitudes in organizational settings. They developed an expanded model of organizational functioning in an open system format, thus relating the components within the model, either directly or indirectly, on a dynamic and homeostatic basis. Some of the components included are the sociocultural and external physical environments; the total organizational context, structure, system norms and values, process and

physical environment; and organizational climate. They suggest integrating models which require analysis of variables from all levels of the organization as well as the external environment. Willems (1973) argues that the traditional models, concepts and theories of behavioral sciences are not appropriate to the demands of behavioral ecology. He further contends that theory and its derivatives offer the tools for understanding interdependence and simultaneous and time-related complexity.

Sells (1969) suggests that one of the important issues of behavioral ecology is to understand the ways in which behaviors and their niches become patterned in terms of adaptive matching. Skinner (1971) argues that "The environment is obviously important... It does not push or pull, it <u>selects</u>, and this function is difficult to discover and analyze." He goes on to say "... the selective role of the environment in shaping and maintaining the behavior of the individual is only beginning to be recognized and studied." Two implications of this view accepted by behavioral ecologists are, first, that behavior is largely controlled by the environmental setting in which it occurs, and second, that changing environmental variables results in the modification of behavior. Wicker and Barker (1972, 1963a) state that the location of the organisms is never unimportant or accidental because behavior and place concatenate into lawful, functioning systems. Wicker calls this "behavior-environment congruence" and agrees with Barker that, for relatively molar behaviors, there is great situational specificity. Barker (1963a, 1968) also points out that behavior settings have such strong principles of organization and constraint that standing patterns of behavior (role definition) remain essentially the same though individuals come and go. Such behavior-environment congruence suggests not only that behavioral functioning and well-being depend on where the person is, but that the specific setting in which persons are observed will affect the professional judgments of how adequately they are functioning

and when one needs to intervene. The investigative problem still remains, however, in describing and classifying the types and patterns of such congruence in human behavior and formulating hypotheses to account for them. This is a key aspect of behavioral ecology and it promises to contribute to programs of design and intervention in human environments.

Barker (1963) makes some additional observations about behavior settings and their effects on patterns of behavior of individuals by elaborating on the number of inhabitants within that setting. Behavior settings with fewer than optimal inhabitants are less differentiated than those with optimal inhabitants (i.e. undermanned). The inhabitants of these underpopulated settings are points of application of more behavior setting forces with wider ranges of direction than are inhabitants of optimally populated settings. Persons which receive more forces in more varied directions will participate with greater forcefulness in more varied ways. As to particular activities, settings with less than the optimal number of inhabitants will result in far-reaching differences, all characterized by stronger motivation, greater variety and deeper involvement. The inhabitants of a behavior setting always have the potential to exhibit a greater variety of behavior than the setting requires or can tolerate. The behavior setting control mechanism reduces this variety to the amount appropriate to the setting. In general, behavior settings with fewer than the optimal number of inhabitants must use deviation-countering control mechanisms, or they will perish. These behavior settings, within which behavioral uniformity is grafted upon personality and diversity, are desegregated, egalitarian, functionally tolerant settings. Settings with a surplus of inhabitants are segregated, uniform and specialized. Behavior settings and the number of their inhabitants are mutually, causally related. Settings have plans for their inhabitants'

behavior, and inputs are activated within the limits of the settings' control systems to produce the planned behavior.

The three studies that follow are examples of the kinds of research methodology being applied in military situations. These particular studies are concerned specifically with determining acceptable criteria for measurement of complex skill behavior, organizational (unit) effectiveness, and occupational performance and satisfaction.

Rampton (1976) conducted an experiment on five groups of Air Observers in the Canadian forces to present the application of a research methodology derived for identifying and interpreting criteria dimensions underlying complex skill behavior. The experimental procedures were conducted in two phases. The first phase reorganized categorized task elements into 169 task functions and the second phase consisted of the groups (Air Observers and their superiors) making similarity judgments between all task functions. Results found task analysis results highly reliable and internally consistent within homogeneous groups (emphasis added); readily and meaningfully generalizable across a variety of work situations; valid in terms of showing significant relationship to external variables; and readily extendible in theoretically and practically important ways in other studies. Rampton felt that when sensibly applied, the methodology would produce reliable, internally consistent and valid results of both theoretical and practical import and could represent a preliminary step in the development of a more adequate criterion technology.

Research conducted by Barker (1976) was concerned with the overall requirement to provide methods and means of improving manpower utilization and promoting organizational effectiveness in the U.S. Navy. An experiment to determine the feasibility of defining organizational effectiveness and acceptable criteria to

assess it was undertaken. This entailed an assessment of the current evaluation subsystem within the Navy in order to provide delineation of the organizational effectiveness concept within that system. The gaps between "what is" and "what should be" were the dimensions of the criteria variables for the agreed upon objectives for that system (input, process, output). A method which assesses the perception of what is a valuable criterion was deemed an acceptable methodology. This method provided a delineation of the current evaluation subsystem within the Navy. The management personnel of four operational units were interviewed and questionnaires were used to structure the requested information. The results of the content analysis of the interviews were tabulated. A consensus of the respondents was used to identify candidate criteria for unit effectiveness measurement. The results indicated that military managers were performance oriented, as reflected in their responses. Consensus within unit type (air, ship, shore, staff) coupled with differences between type provided an indication of potential unit type dependent criteria. The principal differences were between staff and unit, as compared to the other units, which provided possible identification of conflicting goals and directions of the system. Differences between the unit types were primarily variables which related to specific functions characteristic of the unit type.

Secrist (1975) conducted an experiment focusing on man's occupational behavior in context of personal-psychological, organizational-sociological, and physical-architectural factors. He was interested in a multivariate total environment approach to complex occupational performance and satisfaction in a Research and Development area of USAF. His results supported his belief that a total environment methodology is a fertile research approach. He found that personal-psychological variables demonstrated more salient relationships with performance criteria, while organizational-sociological and physical-architectural variables were paramount in the case of satisfaction criteria. Performance and

satisfaction seemed to be associated with compatible if not congruent organizational-sociological climates. Higher multiple correlations were achieved between total environment variables and satisfaction criteria than were found with performance criteria.

In reviewing the literature that investigates maintenance performance (see [illegible], 1979) and also the literature on coping behavior, one quickly becomes aware that little, if any, research has been conducted on how Air Force technicians deal with contextually imposed distractions. An extensive review of the Air Force, DOD, and academic literature uncovered no reference to research on how technicians actually accomplish their maintenance tasks. A review of the "coping" literature indicated that coping is a behavioral way to deal with job-related stress, but no reference was found which tied that stress to attempts to accomplish a task in an environment which has many distractions that frustrates attempts at that task accomplishment. While the concept of "coping" may not be the most appropriate one for investigating the relationship between task and context, at this point in the research it is the most likely candidate.

Paraphrasing Pearlin and Schoder (1978), coping behavior is that behavior that mediates between the individual and the environment. The individual has a demand placed on him or her by a supervisor, contextual distractions make it difficult to accomplish the task properly and/or in a timely manner, and the individual will behave in some way that will mediate the demands of the supervisor and the environment. In terms of a maintenance environment no published research exists which investigates what the mediated behavior is, how it varies across individuals, what impact it has on task accomplishment, or what it means to the technician's motivation.

Cooper and Green (1976) performed a study on RAF airmen on an isolated island and concluded that some airmen handled the isolation better than others and that

the better coping behavior was positively related to job performance ratings. Unfortunately, the only independent variable studied was isolation, along with demographic data, so no conclusions can be drawn about task-related distractions.

The theme that runs through what little information is available on work-related coping is that people cope differently with environmental stimulus. For instance, Howard et al. (1975) found that coping behaviors of managers varied by age. These differences in coping behavior have implications for maintenance performance because up to now it has been assumed that task performance was only influenced by the technical aspects of the job. The fragmentary evidence suggests that performance is also affected by what goes on in the environment within which the task is embedded and that appropriate coping behavior plus technical competence is required for satisfactory performance. This hypothesized relationship could have substantial impact on the accomplishment of Air Force maintenance tasks or what is labeled performance or productivity.

The literature on coping provided some insight into the relationship between task and context. Shalit (1977) analyzed 75 situations of coping in three dimensions: differentiation, the number of alternatives perceived; articulation, the differentiation and rankability of these alternatives; and loading, the emotional loading (positive or negative) associated with the situation. The aim of the study was to investigate how the demands on a person, imposed by the structural complexity of the situation in terms of the above three dimensions, related to his coping ability. The relationship investigated was of each structural dimension to coping, and of the pattern of the interaction of all three dimensions with each other and with the coping process. Shalit (1977) defines coping as an attempt to master a new situation which can be potentially threatening, frustrating, challenging or gratifying. The appraisal of a situation is part of the basis for deciding the

coping response to it. The same situation may be appraised in different ways by the same person at different times, according to the context in which it is met. The researchers were concerned with the objective, structural ambiguity of situations and their effect on coping. They hypothesized that this ambiguity should relate to the efficiency of processing and appraising situations and hence to the efficiency of coping with them. Shalit (1977) suggests that an increase in ambiguity is linked with a decrease in the ability to appraise the situation, and hence to cope with it. Therefore, it is suggested that the ambiguity factor is the first in the hierarchy of situational variables occurring whenever appraisal does. Therefore, it also has the highest threat potential.

Shalit (1977) concludes that articulation was found to be the most crucial factor of the three dimensions. Loading was found to have second importance and might only reduce coping. Differentiation had least importance, which might often not affect coping and it is unlikely that its manipulation would produce beneficial results. Increase of information, which would only increase perceived articulation, would be detrimental to coping.

The integration of systems theory, the ecological school, coping behavior, and the Air Force maintenance environment constitutes a perspective for investigating the maintenance system. Prior research focused on the individual task performer, ignored the context in which the task was imbedded and therefore implicitly assumed that context had no impact on task. This review of the literature and the attendent research challenge that assumption and advance the antithetical argument that system variables and how individuals react to them <u>may</u> control more productivity variance than individual variables only.

III. METHODOLOGY

As this project was a conceptual study the research plan was designed to be modified as new inputs were received. Data were gathered from one Military Airlift Command (MAC) base (Charleston Air Force Base), one Strategic Air Command (SAC) base (Plattsburg Air Force Base), and one Tactical Air Command (TAC) base (Seymour Johnson Air Force Base). The bases were not selected randomly but for geographical proximity and in the case of the SAC base it was selected because of its location in the northern tier of the United States and its attendent severe weather. The sequence of the base visits was arbitrarily decided upon with Seymour Johnson AFB visited first (October, 13-17, 1980), Charleston AFB visited second (November 9-14, 1980), and Plattsburg AFB visited last. The Plattsburg AFB visit was scheduled last (December 7-13, 1980) so that the impact of the onslaught of winter on maintenance tasks could be observed. Coordination for the base visits was accomplished by the Air Force Human Resources Laboratory (AFHRL/LRLM), Wright-Patterson Air Force Base, and on each subject base my contact point was within the Deputy Commander for Maintenance's staff. Coordination and cooperation were excellent and the subject bases' personnel were most helpful. On each base a number of maintenance personnel was observed performing daily tasks and in no instance was work created for the investigator to observe. On two of the three bases I was given a temporary line badge (I have a secret clearance) which permitted my unescorted access to most maintenance areas. On the other base I was not given unescorted access to most maintenance areas which meant that on some observations another maintenance man with escort authority accompanied the observer and the subject.

The project proposal stipulated that a protocol would be devised prior to visit number one, the protocol modified as necessary before base visit number two,

and the protocol revised again, if necessary, before base visit number three. This procedure was followed and it was necessary to modify the protocol after each visit. As the methodology was somewhat different at each base it will be presented in three sections, [illegible] from the prior one.

Base Number One Methodology

Prior to traveling to the subject base, telephone contact was made with the individual at the base who had been identified by AFHRL/LRLM as the contact. Arrangements were made for an initial meeting and it took place early on day one. At this base this occurred on Tuesday morning as Monday was a holiday. The parameters of the project were outlined to the coordinator and a rough sketch of the week's activity was discussed. The contact then provided the names, locations, and telephone numbers of the authorities within the maintenance suborganizations who could authorize and coordinate access to individual maintenance technicians. It was at this time that arrangements were made to get a line badge, if possible. Once I had the names, locations, and telephone numbers of subunit authorities and the contact person had made introductory telephone calls, I coordinated my own activities for the rest of the week.

My approach was to spend one day in each of the the three Aircraft Maintenance Units (AMU^s) and one day in the Component Repair Squadron (CRS).[1] I contacted Maintenance Supervision in each of the units and told them that I wanted to spend approximately one-half day with a "good" technician or crew chief and one-half day with an average or below technician or crew chief. We coordinated times, places and names, and I began my observations at 1300 hours (1:00 PM) on day one.

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1 Base number one was under the POMO Maintenance Structure (AFR66-5) at the time of the visit. Bases number two and three were under the AFR 66-12 maintenance structure.

At 1315 hours (1:15 PM) of day one I contacted the flight chief who was supervising the cold pit where his crew was turning around F-4 aircraft. I introduced myself as a college professor doing research into aircraft maintenance for the Air Force Office of Scientific Research (AFOSR) and explained that I wanted to spend some time observing a "good" crew chief and one who was "weaker". Introductions were made between myself and the subject crew chief and at this time I asked if he would sign a privacy release statement (see Appendix I). After he signed the statement I told him that I was observing maintenance activities to determine "how things got done" and to just go about his activities as if I was not there. I observed the subject crew chief for approximately two hours and then conducted a brief post observation interview (see Appendix II). I repeated the procedure with a second crew chief and left the cold pit area at approximately 1630 hours (4:30 PM).

At 1730 hours (5:30 PM) I arrived in the specialist dispatch area of the same AMU. I repeated my self-introduction to the sergeant in charge and asked to be teamed up with a specialist who was working the middle shift. I inquired if the specialist would mind signing a privacy release statement and then spent the next five and one-half hours following the specialist around and observing as he went about several tasks. Before I left the specialist, I completed the post observation interview. At the end of day one I had spent approximately eight and one-half hours observing two crew chiefs and one specialist, all males.

On the morning of day two, I arrived at the launch area of the second of three AMU^{s} at approximately 0700 hours (7:00 AM). We went through the introductions and I was teamed up with a crew chief. I obtained a privacy release statement and observed this crew chief for approximately two hours. I conducted a post observation interview and was assigned a second crew chief. I obtained a privacy release, spent two hours observing, conducted a post observation interview, and left the flight line area about 1230 hours (12:30 PM).

In the afternoon of day two I went to the specialist dispatch area of the second AMU and after introductions was teamed up with a specialist. I obtained a privacy release statement, observed for two hours, and conducted a post observation interview. At the end of day two I had spent seven and one half hours observing 2 crew chiefs (female) and one specialist (male).

Day three was spent in the third AMU. Because of their late block launch time specialists did not appear in their dispatch area until about 1000 hours (10:00 AM). After the introductions I was teamed up with a specialist, obtained a privacy release statement, observed the specialist for approximately three hours, and conducted a post observation interview. I was teamed up with a second specialist, obtained a privacy release statement, observed the specialist for approximately three hours, and conducted a post observation interview. At the end of day three I had spent six hours observing two specialists (male).

Day four, the last day, was spent in the Component Repair Squadron, an in-shop environment different from the flight line environment. After introductions I was teamed up with a specialist, obtained a privacy release statement, observed him go about his duties for six hours, and conducted a post observation interview. At the end of day four I had spent six hours observing one technician (male).

Over the four day period I spent 28 hours observing four crew chiefs and five specialists.

The observation process was designed to be as unobtrusive as possible and most of the time it was possible to stand in the work area, stay out of the way, and observe the technician as he or she went about the assigned task. My primary concern was how the subjects dealt with distractions from the environment as they attempted to complete the task at hand. In the systems view, or ecological perspective, I was observing the entire system within which one technician attempted to accomplish one task. I was interested in what impact the system had on the task and the individual and how the individual coped with system distractions.

order to achieve successful task completion. Some examples of distractions are extreme noise, weather conditions, lack of special tools, inoperative test equipment, high time pressure, monotony, scheduling, conflicting demands from various supervisors, weapon system [illegible], lack of technical data, need for a new part, darkness, technical incompetency, management policies, lack of training, non-maintenance activities, ground power unit failure, supporting technicians not available at the proper time and place, AFTO form 781 missing from aircraft, tact number changes in the flying schedule, waiting (for everything), lack of transportation, quality of supervision, telephone calls, coordinating activities, and a variety of other task interruptions. <u>The focus of this piece of conceptual research was to investigate what portion of productivity variance might be attributable to systemic variables, how we might measure that, and how the individual technician coped with the system distractions.</u>

<u>Base Number Two Methodology</u>

The coordination of my visit and my schedule for the first half of day one were the same for base two as they were for base one.

At 1300 hours (1:00PM) of day one I went to the "dash twenty-one" section (the old 780 equipment) of the Organizational Maintenance Squadron (OMS). I spent until 1700 hours (5:00 PM) observing a sergeant, first termer, crew chief AFSC, as he and his two helpers rigged passenger seats in and out of aircraft and also rigged an aircraft for an airdrop. I did <u>not</u> conduct a post observation interview as the previous base's results indicated that it was not productive.

Day two was a holiday, Veteran's Day, for everyone on the base except the aircraft maintenance people. MAC's maintenance force works seven days a week, twenty-four hours a day. At 0700 hours (7:00 AM) I met the first term crew chief that I was going to observe for the day. His task for the day was to get his aircraft ready for a 1700 hours (5:00 PM) takeoff. I spent the day observing what

they were doing, how they went about it, the impact of environmental events, and how they coped with what was going on around them. My methodology was to observe, with no questioning, as to what was happening or why. I attempted to be as unobtrusive as possible so that the technicians and their relationships to their and environments would be as normal as possible. No post observation interview was conducted.

Day three was spent on the mid-shift (1600-2400 hours) observing the maintenance crew working out of the Jet Shop Flight line Truck (Field Maintenance Squadron - FMS). The crew consisted of one Technical Sergeant seven level, two Staff Sergeant five levels and two Senior Airmen five levels, all jet engine specialists. Due to circumstances beyond the investigator's control, the level of analysis for this observation was the crew rather than an individual. All previous observations had been on the individual level of analysis. I observed the crew as it went about interacting with its tasks and maintenance environment until approximately midnight when the shift changed. No post observation interview was conducted.

At 0700 hours (7:00 AM) of day four I went to the Avionics Maintenance Squadron (AMS) and spent the day observing a first term radar specialist. The specialist was dispatched from a maintenance shop and when a task was completed he would return to that shop and wait for the next task. The day shift ended at 1600 hours (4:00 PM).

At the end of four days of observation I had spent approximately 29 hours observing two crew chiefs and two specialists. At the end of my observations at base two I had spent a total of 57 hours observing six crew chiefs and seven specialists.

Base Number Three Methodology

The coordination of my visit and my schedule for the first half of day one were the same for base three as for bases one and two. I was not able to arrange an observation for M[illegible] afternoon so one-half of day one was relatively [illegible] productive. The visit to this base was arranged for [illegible] to provide the opportunity to observe maintenance under winter conditions. The weather cooperated and during my visit there was freezing rain, snow, high winds, and subzero temperatures.

Day two was spent observing a Senior Airmen crew chief as he went about his duties in an Organizational Maintenance Squadron's (OMS) phase dock. The work was accomplished inside of a large heated hangar during the day shift and his task was to clear (fix) a number of already written up discrepancies in his assigned work area. My methodology was to interact with the subject as little as possible and to observe the technician as he went about his task and how he coped with environmental events that impacted on that task. Day two ended at shift change at 1600 hours (4:00 PM).

At 1600 hours (4:00 PM) of day three I met the Weapons Control Inertial Navigating (WCIN) specialist that I was to spend the shift with. The WCIN shop was located in the Avionics Maintenance Squadron (AMS). The specialist was dispatched from AMS through the radio in the WCIN shop flight line truck. Again, my methodology was to be as unobtrusive as possible and yet keep the subject specialist, the immediate work area, and the more macro environment under observation. For most of the shift it was cold, very windy, snowing hard, and most activities took place outside. The shift changed at midnight and my observations terminated.

Day four was also spent on the midshift but this time in OMS as I spent the

shift with a crew chief on the flight line. It was bitterly cold (-2°F at 2100 hours) and all the time was spent outside or in the flight line vehicle. I continued my minimally interactive observations until the crew chief got off early at [illegible] hours ([illegible] PM).

The Pneudraulic Shop in the Field [illegible] was the site of [illegible] five's observation and at 0700 hours (7:00 AM) I was teamed up with a first term hydraulic specialist. The specialist was dispatched from the shop to the flight line, some distance away, for various tasks and would generally return to the shop between dispatches. <u>The methodology remained one of unobtrusiveness and minimal interaction</u>. The temperature at the beginning of the shift was 0°F but it warmed up enough to begin snowing in the early afternoon and by shift change it was snowing hard. The observation ended about 1530 hours (3:30 PM) as I had to turn in my line badge and coordinate my departure.

On base three I spent 30 hours observing two crew chiefs and two specialists. The cumulative total for all three bases was 107 hours spent observing eight crew chiefs and nine specialists.

<u>Observation Methodology</u>

The central purpose of this research was to observe Air Force Maintenance personnel as they went about their duties in as naturalistic a manner as possible. Realizing that the observer becomes part of, or perhaps intrudes into, the maintenance environment it was still believed that after some minimal period the observer would blend into the environment if he was unobtrusive enough. After carefully explaining that the observer was not a quality control inspector, not a manpower specialist and that he would not report performance information to anyone, he was well received. The observer then informed the subject that he just [illegible]

to observe how things got done and that he would accompany the subject but the subject was to go about his or her duties as if the observer was not there.

Once at the task site (i.e. aircraft on the flight line) the observer would posit[illegible]. If out of the [illegible] to [illegible], subject behavior, and environmental fact[illegible]. [illegible] outside the aircraft but on larger aircraft it was occasionally inside the air-craft. The observer might have to change position from time to time to keep the subject under view but it was done in a casual manner and seldom elicited attention. Occasionally the subject would remember the observer's presence and would come over to talk, particularly during slack time. In the latter stages of the project the observer stayed with the same subject for one entire shift and went with him or her wherever he or she went. At times that meant spending six hours outside in subzero temperature, standing for several hours in a heavy snowstorm, or getting sunburnt on a hot afternoon in piedmont North Carolina.

At the task site the observer would note the assigned task (some tasks took an hour while others took the whole shift) and then observe how the subject went about accomplishing that task and taking notes on what interrupted task accomplishment and what the subject did about it. Interruptions ranged from needing a clean rag to going on work stoppage until a needed coordinating specialist could be scheduled. Subject coping behavior ranged from dozing under the wing of the air-craft or going someplace where it was warm to aggressively and effectively pursuing a coordinated course of action that resulted in successful task accomplishment.

The observer kept paper and pencil track of the assigned task, subject behavior, environmental events, and interaction between the three, as best he could (it was also dark sometimes). He had come prepared with ear protectors (for noise suppres-sion), [illegible] light, a folding clipboard-type notepad, and [illegible]

appropriate protective clothing for the anticipated weather. The majority of the observation time was spent out in the elements with an occasional respite in a sheltered work area such as a hangar or field shop. The exposed maintenance environment [illegible] it was thought that it offered the most [illegible] environment, the [illegible] of supervisory control, and the greatest likelihood that the hypothesized relationships would be observable.

While the observation methodology needs major revision, particularly in event recording technology (see Appendix III), it did produce useable data. The observer is indeed soon forgotten, events proceed naturally, and the subsequent behavior appears unconstrained, in most cases. The simultaneous observation, recording, interpretation is far more complex than originally assumed but that can be resolved by utilizing a data based categorization scheme recorded in real time on a portable computer (see Appendix III). The main point is that the methodology appears to produce useable information and that information indicates that increased productivity is more of a function of system variables than it is individual variables.

IV. RESULTS

As specified in the project proposal this research was designed to explore how one would go about researching what maintenance personnel do, what events in the environment impact on task accomplishment, and how the maintenance person copes with the interaction between task and environment. In light of the defined objective it was anticipated that some portion of the research's results would be a modification of the methodology as new inputs were received from the research process. The original methodology involved the observer accompanying the technician to a task site with the observation beginning with task preparation activities. The investigator would observe the technician, task, and environment and enumerate distractions and the technician's responses to those distractions. There was to be a post observation interview with the investigator asking the technician what he or she thought the distractions were and how they managed to get the task done in spite of the distractions. This procedure was to be followed for one outstanding technician, selected by the supervisor, and then one average or low performance technician.

Base One Results

The methodology was in trouble from the first hour of observation. The methodology was far too simplistic to observe, record, and interpret the richness and variety of activities and interactions in the environment. The results from base one are divided into two categories, results pertinent to methodology and results pertinent to maintenance, and they are treated separately.

A. Results Pertinent to Methodology - As the original methodology was applied to the research task the following problems were encountered and noted.

1. It is oftentimes difficult to determine precisely what the assigned task is and what the parameters are (i.e. a crew chief recovering and launching an aircraft from a cold pit).

2. It is difficult to determine from observation the impact of some environmental interactions such as temperature (hot), noise level (high), bathroom location (one-half mile away with both males and females on the crew), and availability of potable fluids (low).

3. The observation time of two hours was too brief to observe a representative sample of the subject's behavior.

4. The comparison of coping behavior between a high performer and a low performer could not be made for several reasons:

   a. In most instances there were not enough people available for duty to have the luxury of picking between specialists.

   b. In all but two observations, both specialists, the subjects were first term airmen of approximately equal experience and time in the service and measureable differences in performance probably did not exist, particularly over a short time frame.

5. The post observation interview did not work as the maintenance people did not appear to discriminate task from environment. When they did discriminate they tended to focus on one issue. When asked to explain how they circumvented environmental obstacles they were not aware enough of their own processes to articulate them.

6. The methodology was far too simplistic to observe, record, and interpret the richness and variety of activities and interactions in the environment with paper and pencil technology and one observer.

B. Results Pertinent to Maintenance - As the original methodology was applied to the research task the following distractions pertinent to effective and efficient maintenance were noted.

1. Maintenance personnel spend a majority of their time waiting (for everything) and the slack time is seldom their fault.

2. Almost all maintenance is being accomplished by first term maintenance personnel with two to four years experience. Of the nine maintenance personnel observed on this base only two were beyond their first enlistment and they were both staff sergeant specialists.

3. All things considered, the individual maintenance person does an excellent job in coping with distractions and eventually getting the job done.

4. As a post priori, comparative comment, the flight line maintenance environment of the POMO structure (AFR66-5) is substantially more turbulent than the AFR66-12 maintenance environment.

5. There is little technical assistance available from supervisory personnel and the first term maintenance person must muddle through as best he or she can.

6. Cross Utilization Training (CUT) is not working and there are people attempting to do maintenance on systems that they have only the vagueist idea about. In one instance a specialist was going to unnecessarily have an ejection seat removed in order to get access to a component. He was not working on the system or in the field of his primary Air Force Specialty Code (AFSC).

7. The crew chief's maintenance tasks are comparatively routine but the environment in which the tasks are accomplished is highly turbulent.

Unexpected flight crew arrivals, aircraft tail number switching on the flying schedule, broken aircraft, changing take-off times and other unpredictable events contribute to a high degree of uncertainty. The crew chief deals with the unpredictability by keeping his or her vision narrowly focused and/or by attempting to flee the unstable environment through cross training or seeking jobs in a more stable environment.

8. The decentralization of specialists into the AMU's means that there is no central source of technical expertise. As a result unique malfunctions go unrepaired for extensive time periods.

9. The pressure to generate sorties is so intense and enduring that it overwhelms most other events in the environment. Everything - technical data compliance, safety, maintenance discipline, good supervision - is subordinated to generating the maximum number of sorties. Time pressure causes the environment to be so turbulent that the intensity and magnitude of many "normal" distractions are overwhelmed and they remain below the threshhold of significance.

A review of base one's results and methodology was made before visiting base two and the methodology was modified.

Base Two Results

The basic methodology change was to increase the observation time to one full shift, approximately eight work hours, for each maintenance person observed. Along with the above change the post observation interview was discontinued because it appeared to be contributing little additional information to the research process. It may be that an extensive, probing, post observation interview would contribute valuable input but that approach would consume additional resources, particularly

the subjects' time.

A. <u>Results Pertinent to Methodology</u> - As the modified methodology was applied to the research task the following issues were noted.

1. The increase of observation time to one full maintenance shift is definitely a step in the right direction. However, it is probably still insufficient. If a maintenance person works 200 eight hour days per year he or she works approximately 1600 hours. (Air Force maintenance people probably work far more than 1600 hours per year.) One eight hour shift is one-half of one percent of that total and is probably not a representative sample of a maintenance person's behavior or work patterns. Observing a maintenance person for one forty hour work week would encompass two and one-half percent of a "normal" 1600 hour work year. The amount of observation time required to acquire a representative sample of a maintenance person's activities and work patterns remains a research question and a question that is confounded by varying degrees of environmental turbulence.

2. The precise operational definition of "a task" remains a problem. It is comparatively easy to agree that the changing of a tire has a definite beginning and a definite end and the activities of the maintenance person are engrossed in tire related actions. However, if the task of the maintenance person for the entire maintenance shift is to prepare an aircraft for a 1700 hours (5:00 PM) launch the overall task becomes a series of discrete tasks and it becomes difficult to differentiate between task and environment.

3. The comparision between a high performer's and a low performer's coping behaviors remains an unrealistic objective. Given manning and experience level problems it is not a viable approach to compare extreme behavior without creating additional work. First, the host organization would not permit that; second, the maintenance person does not need additional work; and third, by requiring additional work the investigator would actually be creating an artificial task environment. It might be productive to determine average or normative behaviors and work patterns instead.

4. The observation methodology is a potentially data rich approach to what Air Force maintenance people actually do. However, the richness of the activities overwhelms a paper and pencil (note taking) technology. The availability of a hand-held computer into which observational data could be keypunched and which automatically recorded time would make this type of research much more productive. (See Appendix III)

5. Related to item #2, the operational definition of an environmental distraction is also a problem. If the observer identifies an event as a distraction how can he or she determine the magnitude and intensity of that distraction or should all distractions be considered as the same weight?

B. Results Pertinent to Maintenance - As the modified methodology was applied to the research task the following distractions pertinent to effective and efficient maintenance were noted.

1. Maintenance persons are required to perform maintenance tasks for which there is no training, no technical data, and no test equipment.

2. Coordination when a supporting specialist or crew chief is needed is a continual problem.

3. First term airmen, with attendent skill levels, are performing almost all maintenance and generally without competent technical supervision.

4. The maintenance person works in an environment distinct and separate from the rest of a base's population. The eight to five, five days-a-week world goes about its way with, at best, minimal concessions to the twenty-four hours-a-day, seven days-a-week maintenance schedule.

5. In the specialists' environment events are driven by the random arrival of unscheduled maintenance demands. Specialists pass the waiting time (a major distraction) in a variety of activities designed to consume the idle time.

6. Maintenance personnel function in an environment laden with uncertainty. Seldom do they know exactly what they will do when they arrive at work and that may well be different from what they will do in the second half of the shift.

7. Transportation and communication are consistent major problems.

A review of base two's results and methodology was made before visiting base three and the methodology was again slightly modified.

Base Three Results

The basic change to the methodology was to, if possible, increase the observer's unobtrusiveness. The observer was to stay as far away from the subject and the task at hand as permitted him a clear view of the subject, the task, and the environment. Interaction with the subject was minimized after introductions and

while not rudely turning away interactions initiated by the subject, the observer did not encourage them.

A. Results Pertinent to Methodology - As the modified methodology was applied to the research task the following issues were noted.

1. Instead of one maintenance environment existing there are multiple maintenance environments. The maintenance environment of each of the three major commands differs and the environments are different on each base depending upon where you work. The maintenance environment of a phase dock is different from that of a person with the same AFSC working on the flight line. At the same time the same specialist may work inside a maintenance shop the first part of his or her shift but work outside on the flight line for the rest of the shift. Any assumptions that the Air Force maintenance environment is a monolithic one should be challenged and tested.
2. Extreme weather conditions suggest that the magnitude and intensity of distractions do vary.
3. As a practical matter the observer must be prepared for weather extremes and flight line conditions. The unprepared observer could suffer everything from sunburn to frozen extremities and at the same time damage his or her hearing because of inadequate noise protection. In addition the observer should be familiar with the rudiments of aircraft and maintenance safety as well as security rules and regulations so that he or she does not become part of the problem.
4. The observation time for any one subject is still inadequate. Depending on the flow of maintenance events a maintenance person on

any one shift may or may not be involved in representative, rather than atypical, behavior or work activities. The observation time needs to be increased.

5. The observation effort is spread over too wide an area of maintenance activities for this stage of the research. Instead of observing a variety of AFSCs the observer should confine his efforts to one AFSC (i.e. 431XX crew chief) so that there is more comparability on more similar data.

B Results Pertinent to Maintenance - As the modified methodology was applied to the research task the following distractions pertinent to effective and efficient maintenance were noted.

1. Severe winter weather obviously affects both man and machine. As metal contracts in sub-zero weather maintenance demands differ and increase. At the same time the maintenance person must expend effort to stay warm and keep his or her extremities from freezing.

2. The type and complexity of the assigned weapons system is and of itself a major component of the task environment. The more complex the system, and the harder it is to gain physical access, the more likely severe weather is to compound the maintenance problem.

3. Weapon system reliability and maintainability are increasingly important to the quantity of maintenance demands under extreme weather conditions. (In undermanned, real or perceived, areas excessive demand is a significant distraction.)

4. On some tasks better grouping of tasks or scheduling could improve productivity.

5. Powered Aircraft Ground Equipment (AGE) is a continuing problem and its unreliability wastes increasing amounts of time. Maintenance personnel are less likely to stand around and wait outside for the AGE to be replaced in sub-zero temperatures but will leave the task area to seek warmth.

6. Transportation and communication problems are compounded geometrically by extreme weather.

Partial List of Distractions that Directly Impact on Task Accomplishment:

parts availability	inoperative head sets and ground cords
special tool availability	special test equipment
hand tool availability	volume of paperwork
idle time (nothing scheduled)	weapon system reliability
inoperative or broken AGE	transportation
inadequate communication	distance to task site
slow transportation	distance to bathrooms
slow crew chief or specialist support	distance to heated area
the weather	availability of potable fluids
technical data availability/adequacy	perceived misemphasis on quality control
broken test equipment	time and/or mission pressures
maintenance scheduling	overtime and/or weekend work
changing flying schedule	meals on swing shift and midnight shift
non-maintenance requirements	technical competence
weapon system maintainability	support from non-maintenance activities
inadequate training	poor work methods and habits
technological complexity	inadequate supervision
frequency of supervision	missing aircraft forms
environmental uncertainty	environmental turbulence
interaction with flight crews	perceived status of maintenance
randomness of maintenance demands	waiting time (on task but need something)
manning levels	safety or lack of it
system or component accessability	the maintenance structure (i.e. AFR66-5 vs AFR 66-12)

Note: This list is not organized in order of importance.

It is not suggested that the above list is all inclusive, the frequency of impact is not known, nor is it concluded that the categories are independent factors free of covariance. However, the list results from 107 hours of observation of eight crew chiefs and nine specialists by an observer who is familiar with Air Force maintenance. As such I think that it is representative of what transpired in the

environment of those Air Force maintenance people observed. It must be remembered that random selection of sites or subjects was not accomplished and generalizations from this research to the general maintenance population must be made with extreme care. It is suggested, however, that this list can provide information to begin development of a more sophisticated classification scheme to be used in future research. The implications of this research for the present maintenance environment and how additional research might be done are found in the next two sections.

V. DISCUSSION

As caution must be exercised in generalizing the results of this study to the general Air Force maintenance population, the major issue of concern is the methodology. I believe that the maintenance observations provided the information necessary to devise a sound methodological and analytical schema and also some interesting phenomenological data. This discussion will focus primarily on the methodological issues and will touch briefly and separately on the maintenance issues.

Methodology

The methodology used in this study is too weak to provide hard data for policy making but at the same time it has provided the data to develop a scientifically valid study. The original intent of this study, however, has been satisfied because it was designed as exploratory research and to that end it has been successful. While the study did not produce answers it did help to clarify questions, which was the anticipated outcome. The basic questions raised are: operational definitions of tasks, distractions, and coping behaviors; the complexity of the observation process, including sampling issues; and the hypothesized existence of multiple maintenance environments rather than the assumed monolithic environment.

Operationally differentiating between task, distraction, and coping behavior is not as simple as it first appears. How the task is defined determines what the distractions are and what the distractions are determines the range of coping behaviors available to the technician. If the assigned task of a 431XX (crew chief) is to recover and launch F-4 aircraft from a cold pit what activities is that task "normally" made up of? How the above question is answered determines what activities will be labled distractions that then generate some kind of behavior on the technician's

part. For instance, "normal" cold pit activities consist of servicing and inspecting activities and interacting with the flight crew. Broken aircraft (code 3 for maintenance) are not handled by the cold pit crew but return to another part of the ramp to be handled in a fashion different than the cold pit. However, if in the course of servicing and inspecting a cut tire is identified, the cold pit crew will designate one or more crew members to change the defective tire. In this sense the tire change, although a discrete maintenance task, is a deviation from the "normal" flow of events in the cold pit and would be labled a distraction. How the crew chief assigned to change the tire reacted to the assignment and how he or she actually went about accomplishing the task would be labled coping behavior. Once the tire change began, delays for parts and special tools would be distractions for the tire changing task and how the crew chief reacted to the distractions would be labled coping behavior for that task. On the other hand, a specialist dispatched from the wheel and tire shop to change a main gear tire on a B-52 has as his central task only the changing of a tire and when that task is completed he or she returns to the shop for further dispatch. The crew chief in the cold pit, upon completing the tire change, returns to the central task of servicing, inspecting and launching the F-4 on its next flight. What labeling takes place and what parameters are drawn obviously interacts with operational definitions. A preliminary categorization scheme that addresses these issues is presented in the "Recommendations" section.

The complexity of representative sampling and the observational process itself are the second methodological issue. There is no pretense that the observations in this study are representative of individuals or groups. What a representative observation is is an unknown at this time. However, this observer's experience indicates that the absolute minimum observation length is one workshift but that is probably not enough. A more representative sample would be one work week's activity (five,

eight hour shifts) for one individual. At this observation length, however, other factors such as cost, availability, and the observer's endurance intrude and confound the equation. A further problem in this study is the fact that a broad range (different AFSCs) of maintenance people was observed and comparisons between observations are risky indeed. More, longer observations on maintenance people in the same AFSC are needed to develop a confidence level on the representativeness of the sample.

As previously noted the complexity of the observing process overwhelmed the observer's paper and pencil technology. The problem of operational definitions, the varying turbulence in the different maintenance environments, and the difficulty of keeping track of and interpreting what was going on in the environment combined to discredit the paper and pencil technology. This problem is one of the easiest to solve as in the course of this research I encountered information that led me to a piece of technology (hardware) (See Appendix III). The use of this hand-held computer, combined with a sophisticated categorization scheme and a valid sampling technique, will make possible the kind of study necessary to produce the data that policy decisions can be made from. This approach will be expanded upon in the "Recommendations" section.

The third methodological issue is the one of an assumed monolithic maintenance environment versus hypothesized multiple maintenance environments. If manpower planning or any other resource allocation is done on the basis of an assumed monolithic maintenance environment preliminary, phenomenological data from this study indicate that that assumption should be challenged and tested. SAC's, MAC's, and TAC's maintenance environments differ from each other because of their different missions. The crew chief's maintenance environment differs from the specialist's maintenance environment because of the range of tasks each is involved with. At the same time, it is likely that the crew chief who works in the phase dock functions

in a different environment (in an organizational sense) than the crew chief on the flight line (same AFSC) and the same thing applies to the specialist who works on the bench and the one who works on the flight line. If we assume, from what <u>data base</u> I do not know, that the environment is monolithic and in reality it is not, manpower and other resource planning developed on that false assumption will dysfunctionally distribute scarce resources. Given the complexity of the modern Air Force maintenance world the possibility of multiple environments, and its impact on all aspects of maintenance, should be tested.

While not exhausting the methodological issues in this study the above coverage focuses on the major concerns. I believe that the methodology problems are solvable and suggest a revised methodology in the "Recommendations" section. The second half of this "Discussion" section will deal briefly with maintenance issues.

Maintenance

As mentioned earlier, the maintenance data generated in this study cannot be generalized to the Air Force maintenance population for methodological reasons. However, in a phenomenological sense, the observation data has face validity. The predicted phenomena and relationships within the phenomena exist and the significance to increased productivity is higher than originally assumed. The three areas to be discussed here are the frequency and intensity of environmental (situational) distractions (constraints), the coping behaviors of maintenance people, and maintenance peoples' perception of what impedes productivity.

The frequency and intensity of environmental distractions is some function of the degree of environmental turbulence. The environment in a field shop or phase dock is relatively less turbulent than a flight line environment and therefore fewer distractions are encountered. However, the entire maintenance environment

is more turbulent and less predictable than the clerical support environment and a significant portion of a maintenance person's time is spent dealing with environmental distractions. The non-representative data indicate that 50% or more of a maintenance person's time is consumed in coping behaviors stimulated by environmental events. A substantial portion of the variance in the productivity equation can probably be accounted for by events external to the individual maintenance person and therefore beyond his or her control. The popular mythology is that the majority of the variance in the productivity equation is controlled by the individual maintenance person and the sketchy evidence from this study indicates that the situation, rather than the individual, contributes the majority of the variance. If future research confirms the preliminary data in this study managers could derive greater productivity increases at less cost by proper control of the environment rather than focusing all productivity efforts on the individual maintenance person.

The second observation deserving comment here is what it is that the maintenance person complains about. In most of the cases observed maintenance persons liked their job but disliked environmental events surrounding it. They pointedly attacked segments of the maintenance environment and specifically perceived that, rather than assisting, environmental events hindered maintenance efforts. They are adamant and vocal about this, particularly since in two of the three bases no effort was made to collect this type of information. Unfortunately, it would take a lengthy, probing interview to sort this information into useable data and available resources precluded that effort. Not only do environmental events appear to control the majority of productivity variance from the observer's point of view but the hands-on maintenance people verbalize a similar perception.

The third observation is that the individual maintenance person is doing a good to excellent job (sample not representative) and engages in reasonably positive coping behaviors from a productivity point of view. However, their coping behaviors are often contradictory to organizational policy, to them a perceived distraction. What they are experiencing is the frequently concealed conflict between pressure for maximum sortie generation and compliance with organizational policy. The official point of view is that these two objectives are one and the same while the maintenance person views them as mutually exclusive. To them organizational policy and structure are part of the environmental distractions that steal valuable time from what is really important. The maintenance person is productivity oriented and strongly resents environmental events that interfere with task accomplishment. Management might achieve significant productivity gains at low cost by better control of distracting environmental events. This strategy should produce quick returns and is easier to implement than significant attitude change.

After experiencing three weeks of maintenance observation I am reasonably convinced that the basic ideas in this study are supportable and that valid and reliable data can be collected. I believe that a sound methodology can be developed from this preliminary study and I know that a valid sampling schedule can be worked out. I am convinced that this line of research will have a measurable impact on the productivity question and while the dollar cost could be low the organizational cost could be high. How I visualize a larger research project that corrects the flaws in this study is contained in the "Recommendations" section.

VI. RECOMMENDATIONS

In order to produce results generalizable to the Air Force maintenance population a stratified random selection of sites (bases) and individuals must be developed. To keep the sample size reasonable the study should concentrate only on one Air Force Specialty Code (AFSC) and I suggest that it be 431XX, crew chief. The sample would be stratified by command (MAC, SAC, TAC), by skill level (431X3, 431X5, 431X7, 431X9), and by type of aircraft; but, once stratified, selection within the strata would be random. The total sample size would depend upon how many 431XX^s there are in how many locations. Random selection of sites could be done at any time once the population was identified while the random selection of individuals would be done on each individual site using the unit's master roster of personnel assigned in the 431XX AFSC. The sampling problem is a standard one and compared to the other issues is easily solved.

The toughest problem is a manageable, sophisticated classification scheme that realistically encompasses all of the activities that the observer might encounter. What makes the whole project feasible is the hand-held computer typified by the material in Appendix III. A coded classification scheme could be developed, within the capabilities of the hand-held computer, that would permit the observer to keep accurate account of a variety of tasks, events, and subsequent behaviors. To solve the problem of tasks within tasks (i.e., cold pit crew changing a tire) a scheme that provided codes for primary, secondary, and tertiary tasks could be devised. The overall scheme would need codes for tasks codes for environmental distractions, and codes for the coping behavior resulting from the distraction. The hand-held computer has an internal clock and all entries would have time references. For example: on a fourteen character keyboard the first six digits could be used to code primary, secondary, and tertiary tasks; digits seven through ten could be used

to code distractions, and digits eleven through fourteen could be used to code coping behavior. From a preconceived coding scheme the observer would select the appropriate numbers and punch them into the hand-held computer resulting in a minimum of recording time and a maximum of observing time. With some practice the observer would become quite adept and should be able to keep up with the pace of environmental events. When the day's observations are finished the hand-held computer is plugged into a big computer and the data is directly dumped into the big computer. Depending on the facilities available the day's raw data is available in print out form in a short time and can be reviewed and corrected if necessary while the observer's memory is fresh. The stored data in the computer accumulates and data analysis can be performed at the investigator's discretion. The information for the content of the Task, Distraction, and Coping Behavior dimensions of the coding scheme is available and could be fleshed out, if necessary, during a pretest. A pretest of the sampling, classification, and observation recording methodology would be necessary and could be completed in a one week field trip. Compared to survey research this type of research would be relatively expensive but would result in hard data about what maintenance people actually do rather than self-report data which is historically unreliable.

As a consequence of this feasibility study I am reasonably convinced that a larger study that is conceptually sound and methodologically valid is possible. The results of such a study would be generalizable to the entire Air Force maintenance population and would provide reliable data for policy making decisions. The following section concludes this study and ties all of the ends together.

VII. CONCLUSION

This Air Force Office of Scientific Research (AROSR) Minigrant Project has been a learning experience, it was designed that way. Because of resource constraints the study was limited in scope but it has generated valuable information. The conceptual development appears sound, the methodological problems are resolvable, and the information that a larger study would produce is important to Air Force maintenance management. Productivity, however measured, will continue to be an issue and the speculative data from this study indicate that management has ignored an area that has a potential for high payoff in productivity increases. The issue and the methodology are worth pursuing.

Traditionally, management has focused its productivity efforts on the individual at the bottom of the organizational hierarchy who engages in the hands-on core technology. This approach assumes that the hands-on Air Force maintenance person controls a substantial portion of the variance in the production equation. What additional resources that are committed are committed to doing something to the individual to increase productivity. The conceptual argument contained herein challenges the above assumption and suggests instead that environmental distractions (situational constraints) dominate the variance in the productivity equation. A highly motivated, competent maintenance person may not be productive but it will be the fault of the environment in which the task is contained, not the fault of the individual. If the tentative evidence in this study is borne out there is a much higher potential for increasing productivity by changing the environment rather than the individual.

Resource allocation is currently accomplished under the assumption that the planners know how maintenance people "really" spend their time. The tentative data from this study suggest that maintenance people spend 50% or more of their time coping

with distractions which further suggests that planners substantially overestimate the time per maintenance person available for task accomplishment. Among other outcomes, the expanded study outlined above would provide hard data on how much time (NOT time-motion study) is available for actual task accomplishment and could provide valuable information to resource allocators.

The bottom line is that data from the above suggested study could provide managers and resource allocators with the information on how to attack productivity issues from a new direction. Not only is it necessary to recruit, select, train, and assign qualified maintenance people it is also necessary to insure that the environment in which their tasks are imbedded does not impede or distract from task accomplishment. It is the latter issue that needs increased attention from management and this line of research could provide managers with the information to better manage the maintenance environment. As Peters and O'Conner comment (*Academy of Management Review*, 1980, vol. 5, 3, 391-397)

> Situational constraints relevant to performance outcomes remain a relatively unexplored source of variance of potential importance to both researchers and practitioners alike. This frequently overlooked construct is hypothesized to affect both the level of obeserved (sic) performance and individual difference/work outcomes as well as satisfaction/performance associations. The limited empirical evidence available clearly justifies the need to further explore the direct and indirect effects of situational variables as partial determinants of these outcomes. (p. 396-397)

APPENDIX I

PRIVACY RELEASE STATEMENT

I have been informed by Dr. William Kane that according to the Privacy Act of 1974 (Public Law 93-579, 31 Dec. 74, 5 U. S. C. 552a) my participation in this project is voluntary. If I do not wish to participate it will not be held against me and I do not have to state why I do not wish to participate.

If I do participate I understand that Dr. Kane is not here to monitor the quality of my performance and that he will not report back to my supervisor. The data gathered on me as an individual will be combined with other individual data and the ability to identify my individual results will disappear in the aggregation.

I hereby give permission for the use of my information with the understanding that it will never be attributed to me personally.

______________________________ ____________________

Signature Date

APPENDIX II

POST OBSERVATION INTERVIEW QUESTIONS

William D. Kane, Jr., Ph.D.

Western Carolina University

Rank_______________ AFSC_________________ Date___________

Base_______________ Command______________

1. How many years service do you have?

2. How many years of experience do you have in this AFSC?

3. How long have you been assigned to the base?

4. How long have you worked on your current weapons system?

5. What events occurred since you were assigned this task that slowed you down or made it difficult for you to complete the task?

6. What did you do, what action did you take, to get around or eliminate that which was interferring with task accomplishment?

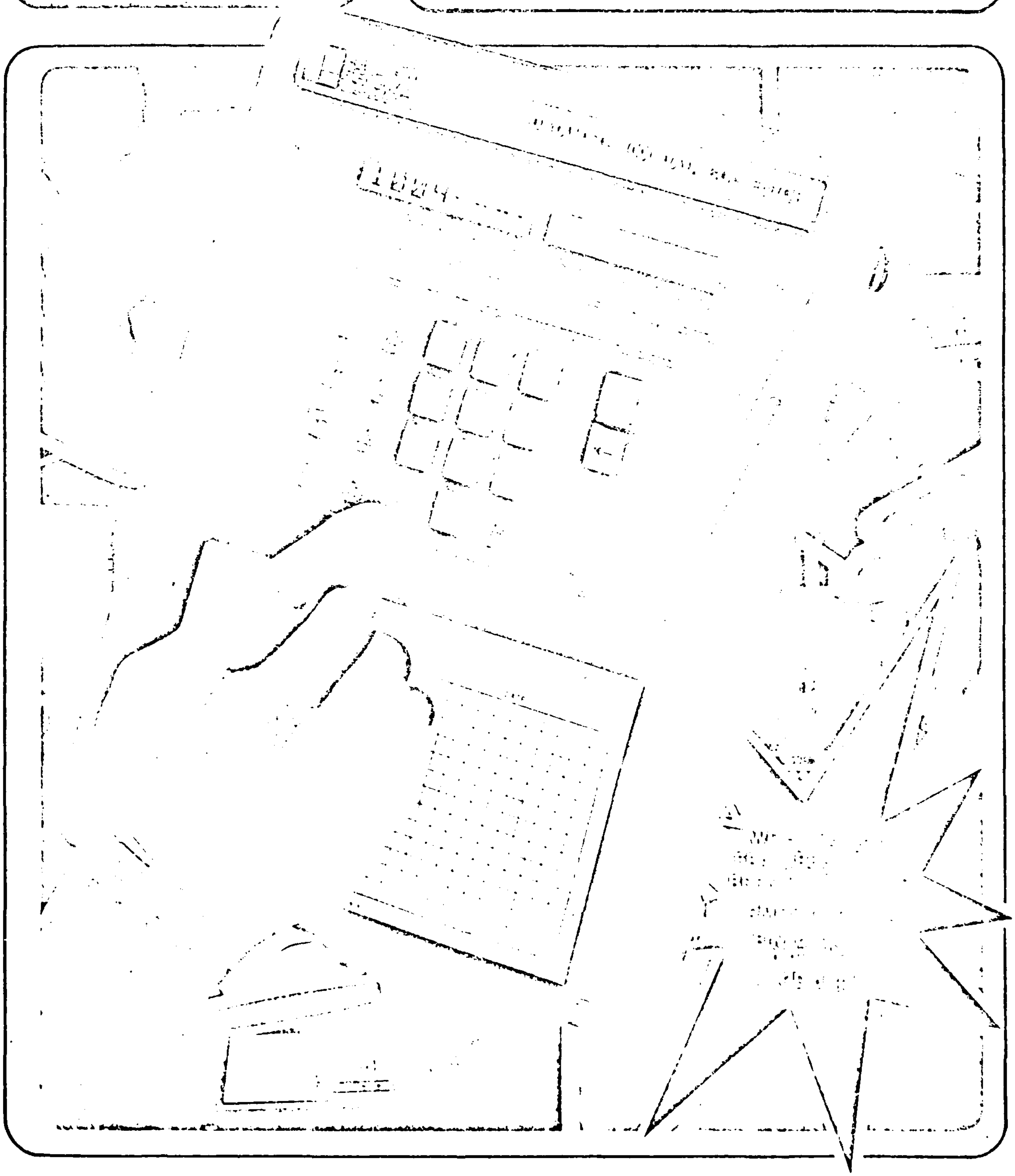
7. How often do these kinds of events hinder your job accomplishment?

8. What percent of your direct labor time is generally consumed in dealing with events that interrupt the maintenance task?

9. How do you know what to do when one of these disruptive events occurs?

10. How often are your actions successful in resolving the interruption so that you continue with the maintenance task?

APPENDIX III



DATAMYTE: THE MISSING LINK

Computers have long made up the last two links in the three-link chain of data collection, processing and reporting. But it wasn't until the introduction of the first Datamyte in the mid '70s that the first link — data collection — was supplied, and fully computer-aided behavioral studies became a reality.

BASIC BENEFITS UNCHANGED

Easier, faster, more reliable data collection is what you might expect from a solid-state electronic data collector. But this is just a small part of the Datamyte benefits story.

Of much greater significance is the time and money saved at the processing/reporting stage. Because of Datamyte's interface capabilities with computers, yours or time-share, comprehensive printed reports are yours within minutes following data collection.

No more need for tedious, time-consuming reductions, calculations and keypunching. No more chance for human error.

WHAT IT IS

The Datamyte 1000 is a general purpose, hand-held data collector with a solid-state memory capable of storing up to 48,000 characters in a computer-readable format. Rechargeable battery power permits at least 12 hours of operation, anywhere. Following data collection, the data is transmitted via an interface cable to your computer for report generation.

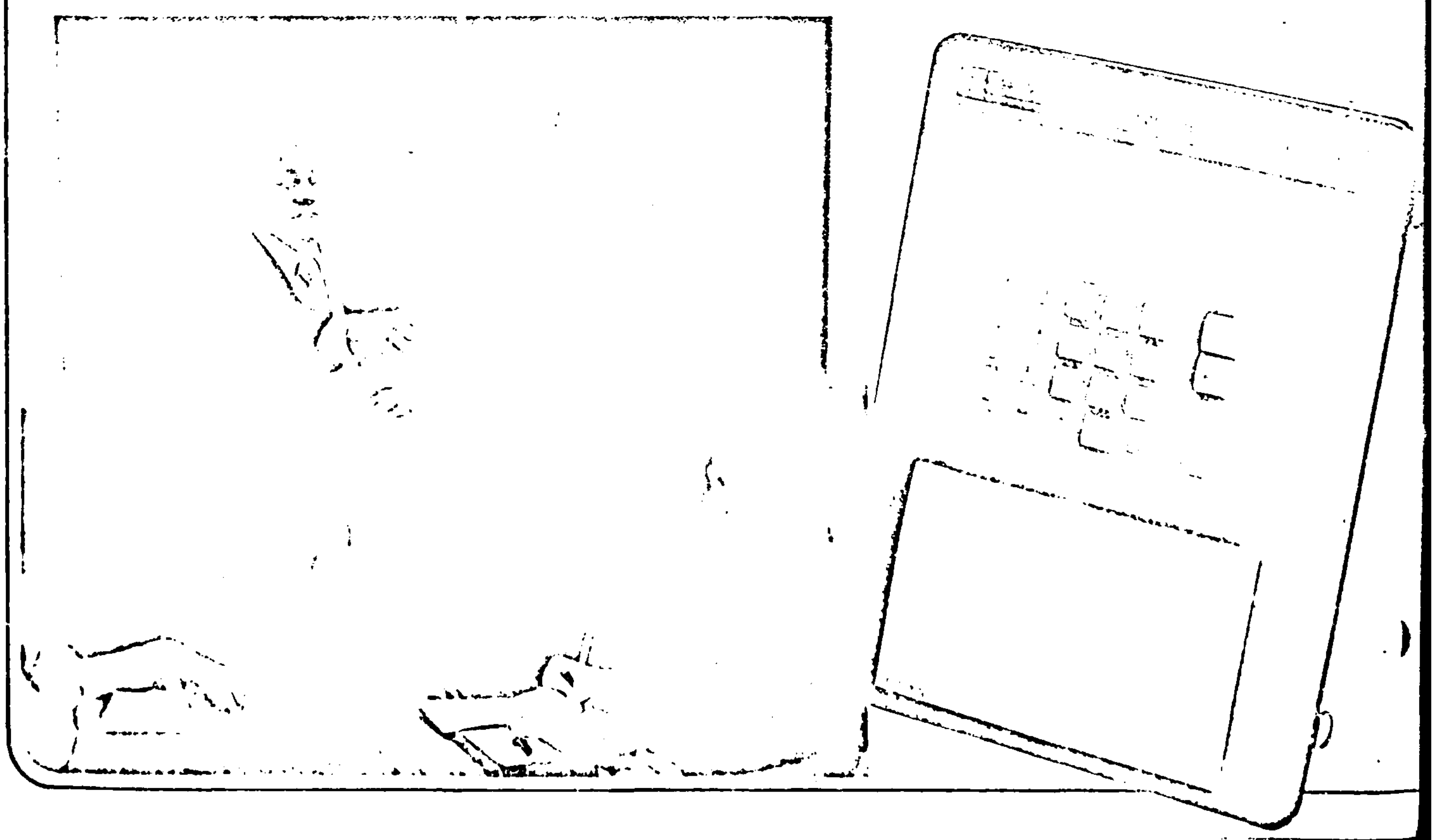
NEW 1000 SERIES OFFERS NEW FEATURES/BENEFITS

This latest generation of Datamytes still offers the same time-proven benefits, but now it has been updated to reflect both customer requests and the latest advances in technology. Check NEW FEATURES (next page) for details on CMOS technology, LCD display and environmental protection.

MODEL 1004

As with the Datamyte 904, the new 1004 is an excellent tool for behavioral research, allowing you to spend more of your time observing. And you can forget about reading, interpreting and entering time. It's handled automatically. Equally important, the Datamyte adapts easily to your other data collection needs.

Besides the Datamyte, you'll need a computer



and computer program(s). If you don't have access to a computer, we can direct you to a low cost, nationwide time-share service.

DATA TRANSMISSION . . . "INSTANT" PROCESSING

Stored data is transmitted directly to a time-share terminal or mini-computer by means of a simple interface cable. The Datamyte transmits serial ASCII (American Standard Code for Information Interchange) into RS232C or 20 mA current loop devices.

Data is then processed by calling up the appropriate computer program. Within minutes a professional, computer-written report is in your hands.

[illegible]

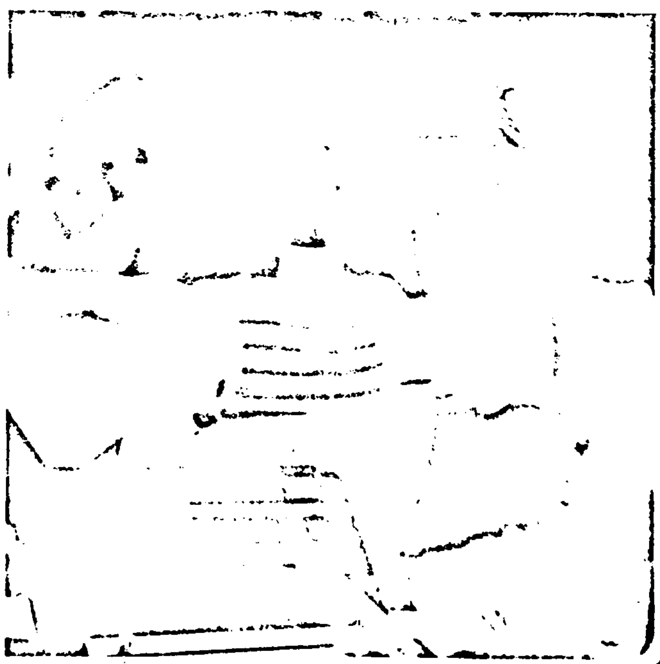
- Easier, faster, more reliable data collection.
- Observer can spend much more time observing . . . time is recorded automatically.
- Because Datamyte interfaces directly with computers, computer-printed reports are available within minutes after data collection.
- Considerable savings in processing/reporting time alone.
- No more need for manual reductions, calculations and keypunching. No more chance for human error.
- Datamyte easily adapts to your individual data collection needs . . . your basic procedures.
- Battery powered, hand-held portability.
- Lightweight, portable . . . twelve hours or more of data collection for each battery change.

NEW FEATURES

- CMOS technology for lower power requirements . . . longer operating periods between battery recharges. Unit can be turned off without losing memory.
- LCD (Liquid Crystal Display) for easy reading in direct sunlight . . . lower power requirement.
- Environmental protection from dust and rain with flexible, transparent keyboard cover.

DATAMYTE 1004

INTRODUCTION		Replaces Model 904. Offers the same features and works with the same computer programs. An adapter permits using 904 interface cables.
APPLICATIONS		Usable in every known area of behavioral study . . . mother-infant, teacher-student, mental retardation, child aggression, group interaction and animal behavior.
CAPABILITY		Up to 48K memory. Numeric keyboard with 14 characters: 0-9 and C, F, H, *.
INPUT MODES	1	DATA + TIME are recorded upon keying ENTER.
	2	ONE-DIGIT AUTOTIME: Records data plus time upon keying any one of the 14 character keys.
	3	TWO-DIGIT AUTOTIME: Records data plus time upon keying any two of the 14 characters.
	4	DATA ONLY: Records data only upon keying ENTER.



DATAMYTE 1000 ACCESSORIES

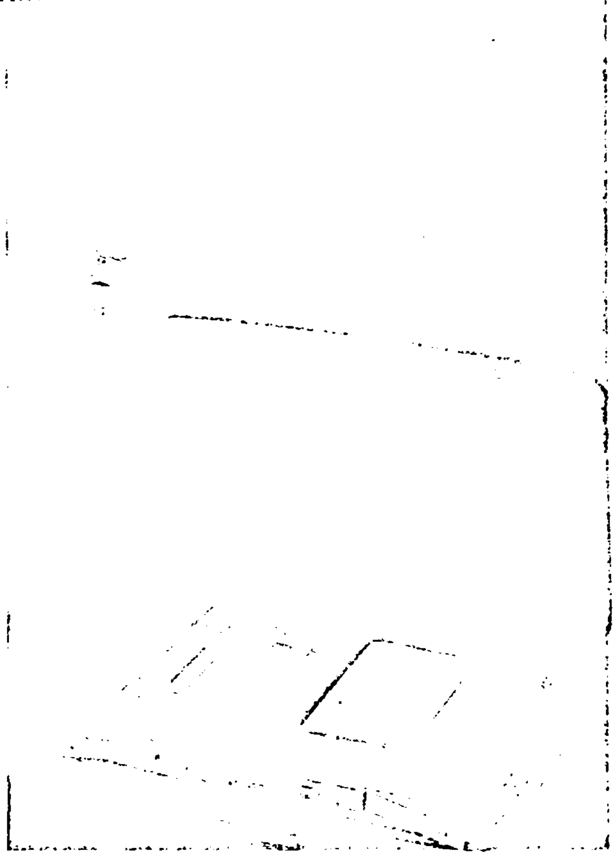
An interface cable and a battery charger are required accessories, and a spare battery is highly recommended. All others are optional.

INTERFACE CABLE: A wide selection of interface (output) cables is available for connecting the Datamyte 1000 to a variety of computer terminals, minicomputers or microcomputers. See back of price list for complete listing.

1012 BATTERY CHARGER: Recharges a fully discharged batter in 14-16 hours, and can also be used as an AC adapter for maintaining memory. An accessory adapter permits charging a spare battery. Rotating batteries permits around-the-clock operation. (A small built-in standby battery maintains memory while exchanging main batteries.)

1015 SPARE BATTERY: With a spare battery there is no need to hold up Datamyte operation while waiting for battery recharging . . . a time-saving convenience whenever the Datamyte is in frequent use.

1022 CARRYING CASE: This durable ABS plastic attache case is lockable. The custom-cut foam rubber insert is designed to protect and hold the Datamyte 1000, a battery charger, spare battery and an output cable.



SPECIFICATIONS

SIZE: 13 x 10 x 1.5 inches
WEIGHT: 3 lbs.
HOUSING: Black ABS plastic
SCRATCH PAD: 4.25 x 7 inches
NECK STRAP: Removable, positionable
OPERATING TEMP: 40° - 120°F
MAIN BATTERY: 12 hours operation, rechargeable, removable
STANDBY BATTERY: 15 hours memory retention
KEYBOARD: C, F, H, *, 0 thru 9. Also CR (carriage return)
CLOCK: In seconds, or hundredths or thousandths of a minute (selectable)
INTERVAL TIMER: Switch selectable in intervals of 3, 5, 10, 15 and 30 seconds, or 1, 2, 5 and 10 minutes.

MEMORY: 4K, 8K, 16K, 32K or 48K characters
ENTRY RATE: 10 keys per second, max.
OUTPUT: ASCII, RS232C (or 20 mA current loop optional)
OUTPUT RATE: Selectable baud rates of 110, 150, 300, 600, 1200, 2400 or 4800. Or user provided baud clock (16 times baud rate up to 4800 max.)

EXTERNAL CONTROL:
DC3 — Stop Transmission (13-HEX)
DC1 — Resume transmission (11 HEX)
BEL — Resume transmission (07 HEX)

DISPLAY: 16 digit, 0.315-inch LCD (numeric)

NOTE: Specifications subject to change without notice.

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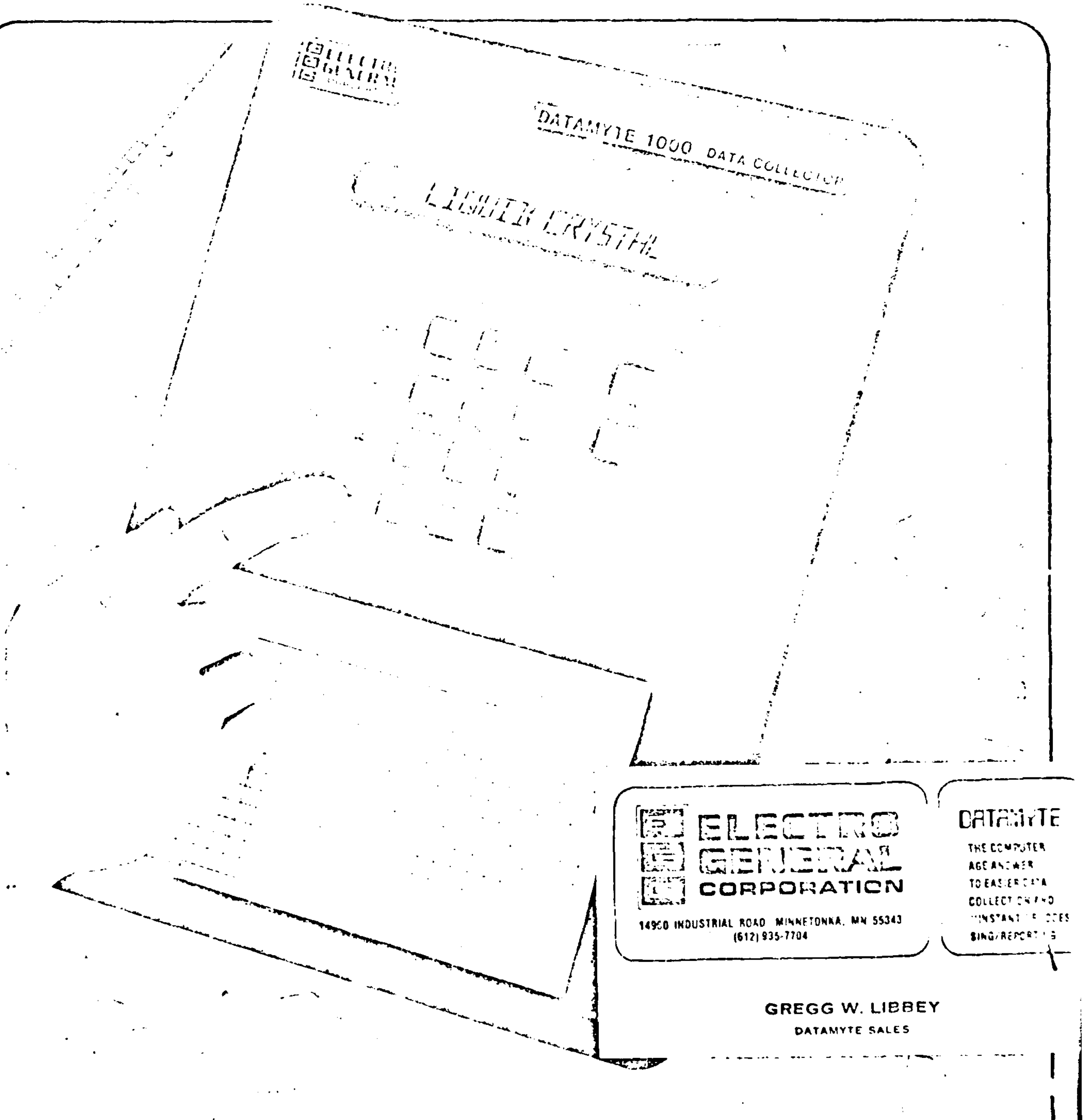
(612) 935 7704 • TELEX 29 0803

NEW DATAMYTE 1000 . . .

More reliable data collection, together with "instant" processing/reporting, makes computer-aided work measurement affordable



BASIC DATAMYTE BENEFITS [illegible]

Easier, faster, more reliable data collection is what you might expect from a solid-state electronic data collector. But this is just a small part of the Datamyte benefits story.

Easier, faster, more reliable data collection.

Observer can spend much more time observing . . . time is recorded automatically.

Because Datamyte interfaces directly with computers, comprehensive printed reports are available within minutes after data collection.

No more need for manual reductions, calculations and keypunching. No more chance for human error.

Provable savings of up to $10,000 a year in processing/reporting time alone on many applications.

Datamyte easily adapts to your individual data collection needs . . . your basic procedures.

Computer pre-loading of the Datamyte cuts amount of data to be entered . . . provides operator prompts that virtually eliminate chances of missing important data.

Entries can be recalled, edited and even compared with entries of the previous study.

Battery powered, hand-held portability.

Lightweight, portable . . . twelve hours or more of data collection for each battery change.

CMOS technology for lower power requirements . . . longer operating periods between battery rechargings. Unit can be turned off without losing memory.

LCD (Liquid Crystal Display) for easy reading in direct sunlight . . . lower power requirement.

Environmental protection from dust and rain with flexible, transparent keyboard cover.

Alphanumeric capability and bar code wand . . . to be announced later (retrofittable).

Of much greater significance is the time and money saved at the processing/reporting stage. Because of Datamyte's interface capabilities with computers, yours or time-share, comprehensive printed reports are yours within minutes following data collection.

No more need for tedious, time-consuming reductions, calculations and keypunching. No more chance for human error.

WHAT IT IS

The Datamyte 1000 is a general purpose, hand-held data collector with a solid-state memory capable of storing up to 48,000 characters in a computer-readable format. Rechargeable battery power permits at least 12 hours of operation, anywhere. Following data collection, the data is transmitted via an interface cable to your computer for report generation.

NEW 1000 SERIES OFFERS NEW FEATURES/BENEFITS

This latest generation of Datamytes still offers the same time-proven benefits, but now it has been updated to reflect both customer requests and the latest advances in technology. Check NEW FEATURES (left) for details on CMOS technology, LCD display and environmental protection.

MODEL 1006

As with the Datamyte 906, the new 1006 is an excellent tool for work measurement applications, allowing you to spend more of your time observing. And you can forget about reading, interpreting and entering time. It's handled automatically. Equally important, the Datamyte adapts easily to your other data collection needs.

Besides the Datamyte, you'll need a computer and computer program(s). If you don't have access to a computer, we can direct you to a low cost, nationwide time-share service. Also, we have both time study and work sampling programs accessible on time-share, either of which you can rewrite, if necessary, to fit your own computer. For details, ask for Technical Bulletin 154 (Time Study) or 158 (Work Sampling.)

OTHER APPLICATIONS

For information on using the Datamyte in other applications, ask for these bulletins:

103 - Downtime Recording
105 - Predetermined Time Systems

MODEL 1006 FUTURE FEATURES

The two new optional features to be announced later — alphanumeric capability and bar code wand — will be retrofittable to previously purchased 1006 units.

DATA TRANSMISSION...

[illegible]

Stored data is transmitted directly to a time-share terminal or mini-computer by means of a simple interface cable. The Datamyte transmits serial ASCII (American Standard Code for Information Interchange) into RS232C or 20 mA current loop devices.

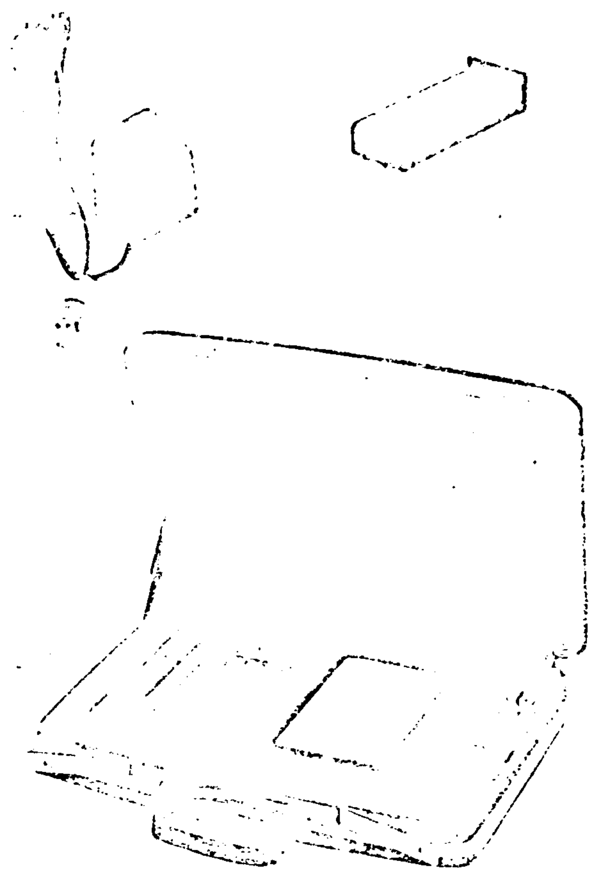
Data is then processed by calling up the appropriate computer program. Within minutes a professional, computer-written report is in your hands.

DATAMYTE 1006

INTRODUCTION		Replaces Model 906. Offers the same features, and works with the same computer programs. An adapter permits using 906 interface cables.
APPLICATIONS		Time study, work sampling, downtime recording, predetermined time systems, event recording, gauge reading and traffic studies. (NOTE: Ask for tech reports on these subjects.)
CAPABILITY		Up to 48K memory. Numeric keyboard with 14 characters: 0-9 and C, F, H, *
INPUT MODES	**1**	**DATA + TIME** are recorded upon keying ENTER
	2	**ONE-DIGIT AUTOTIME:** Records data plus time upon keying any one of the 14 character keys.
	3	**TWO-DIGIT AUTOTIME:** Records data plus time upon keying any two of the 14 characters.
	4	**DATA ONLY:** Records data only upon keying ENTER.
	5	**DATA + EDIT:** Data is recorded upon keying ENTER and the recorded data may be edited.
	6	**DATA + EDIT + DOWNLOAD:** Allows entire memory to be downloaded with prompt and data fields. Also allows editing, except for prompts.
	7	**DATA + TIME + EDIT + DOWNLOAD:** Same as In-Mode 6, but with time field added.

[illegible] ACCESSORIES

An interface cable and a battery charger are required accessories, and a spare battery is highly recommended. [illegible] are optional.



INTERFACE CABLE: A wide selection of interface (output) cables is available for connecting the Datamyte 1000 to a variety of computer terminals, minicomputers and microcomputers. See back of price list for a complete listing.

1012 BATTERY CHARGER: Recharges a fully discharged battery in 14-16 hours, and can also be used as an AC adapter for maintaining memory. An accessory adapter permits charging a spare battery. Rotating batteries permit around-the-clock operation. (A small built-in standby battery maintains memory while exchanging main batteries.)

1015 SPARE BATTERY: With a spare battery there is no need to halt the Datamyte operation while waiting for battery recharging . . . a time-saving convenience wherever the Datamyte is in frequent use.

1022 CARRYING CASE: This durable ABS plastic attache case is lockable. The custom-cut foam rubber insert is designed to protect and hold the Datamyte 1000, a battery charger, spare battery and an output cable.

SPECIFICATIONS

SIZE: 13 x 10 x 1.5 inches
WEIGHT: 3 lbs.
HOUSING: Black ABS plastic
SCRATCH PAD: 4.25 x 7 inches
NECK STRAP: Removable, positionable
OPERATING TEMP: 40° - 120° F
MAIN BATTERY: 12 hours operation, rechargeable, removable
STANDBY BATTERY: 15 hours memory retention
KEYBOARD: C, F, H, * and 0 thru 9. Also CR (carriage return)
CLOCK: 000.00 - 999.99 min. ± 0.01
INTERVAL TIMER: Switch selectable in intervals of 3, 5, 10, 15 and 30 seconds, or 1, 2, 5 and 10 minutes

MEMORY: 2K, 4K, 8K, 16K, 25K bytes (maximum of 48K keyboard characters)
ENTRY RATE: 10 keys per second, max.
OUTPUT: ASCII, RS232C (or 20 mA current loop optional)
OUTPUT RATE: Selectable baud rates of 110, 150, 300, 600, 1200, 2400 or 4800. Or user provided baud clock (16 times baud rate up to 4800 max.)
EXTERNAL CONTROL:
- **DC3** — Stop Transmission (13-HEX)
- **DC1** — Resume transmission (11 HEX)
- **BEL** — Resume transmission (07 HEX)
- **ACK** — Transmit next line (06 HEX)
- **NAK** — Transmit last line (15 HEX)

DISPLAY: 16 digit, .315-inch LCD (numeric)

NOTE: Specifications subject to change without notice.

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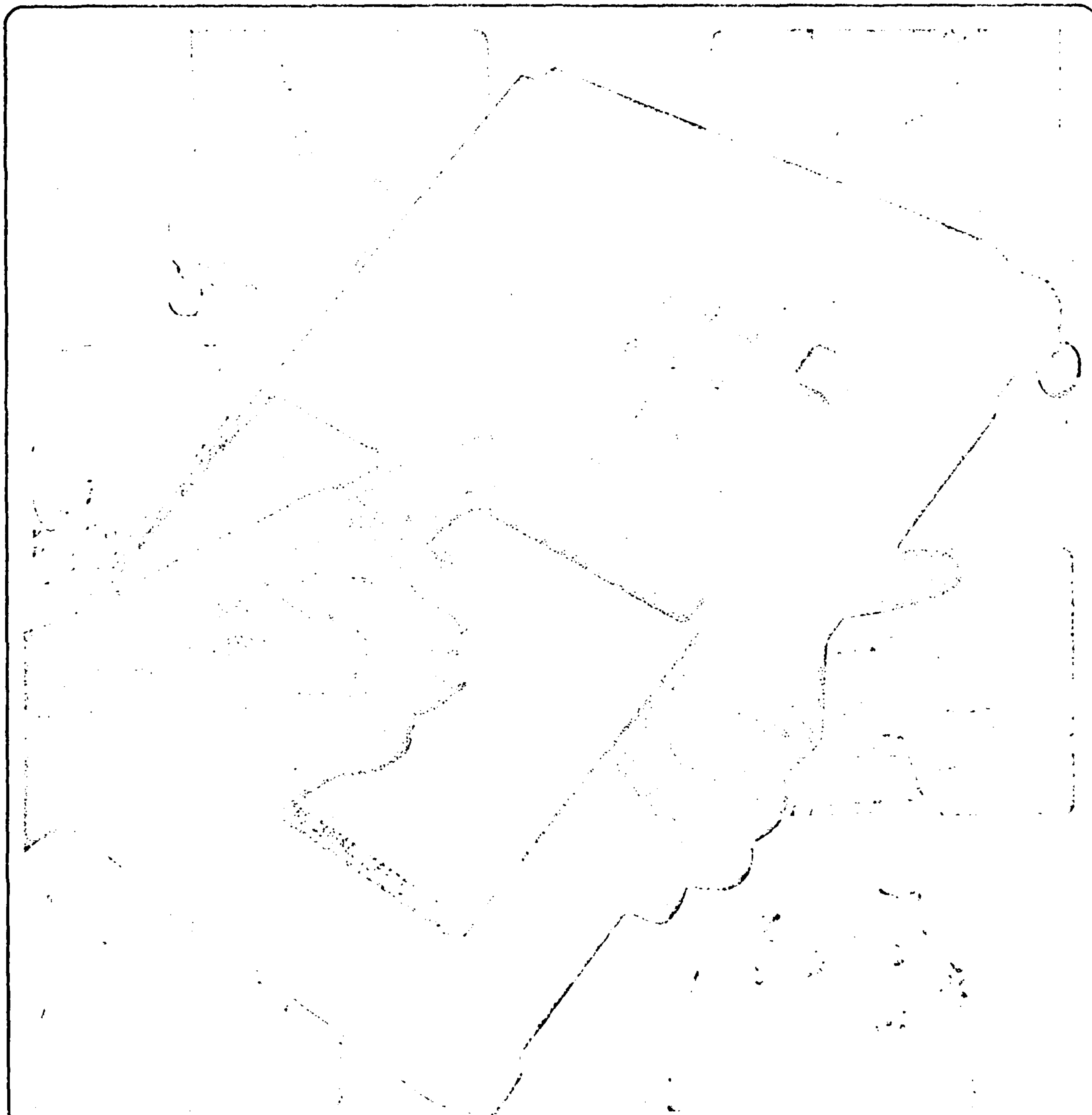
CORPORATION

How the DATAMYTE facilitates data collection and processing for modern behavioral research

112



OBJECTIVE: The application of the Datamyte to research in behavioral research is limited only by one's imagination. So the following case studies were selected to suggest the wide range of research projects on which this instrument can be used effectively. In each case the various hardware and software packages are identified, as are the coding schemes.

Not only does the Datamyte permit faster, more reliable data collection, but, because of its computer interface capabilities, processed, comprehensive, printed reports are available within minutes.

PARENT-CHILD ATTACHMENT BEHAVIOR IN HOME AND LABORATORY SETTINGS*

by: Robert B. Stewart, M.A.
Robert L. Burgess, Ph.D.

Division of Individual and Family Studies
The Pennsylvania State University
University Park, Pennsylvania 16802

ANALYSIS:

This study measures the frequency, duration and rate of behavior enchange within dyadic and triadic groups.

SOFTWARE:

Contributed by Donald L. Hazle
- BOSSPROG – rate analysis program
- BOSSPROX – DATAMYTE rate analysis program
- BOSSRELY – inter-coder reliability program
- BOSSSCAN – data check program

SAS
SPSS

HARDWARE:

IBM 370 – 168

ABSTRACT:

The primary objective of this study was to observe parent-child interaction, with an emphasis on predefined attachment behaviors, such that a descriptive data base might be obtained for the effects of two ecological settings on the phenomena commonly observed during the separation and reunion of parents and their young children. Dyadic and triadic situations were observed and a systematic sample of the behavior of the parents, the children and two adult companion figures was recorded. Behavior was coded with respect to a designated focal subject. Analyses focused upon the frequencies, mean and relative rates of behavior exchange, reciprocity and S-R type interacts. Preliminary analyses of earlier data indicate that parents tend to anticipate their child's need for comfort and provide appropriate behaviors before the child becomes distressed and initiate behavior towards the parent(s).

*A complete description of a similar project was presented at the Fifth Biennial Southeastern Conference on Human Development, Atlanta, Georgia, April 1978. (Reprints available.)

CODING SCHEME:

Column 5, One Digit – Focal Subject

Type of Interaction (1st column)

Verbal give	1
Verbal receive	2
Physical give	3
Physical receive	4

Qualifier Code (3rd column)

Attachment	1
Sociable/Affiliation	2
Fear/Wariness	3
Approach	4
Ignore	5
Unaware	6

Other Actor (5th column)

Person x to 10

New Focal Subject	= 99999
End of Session	= 77777
Begin New Session	= 55555
Begin Data	= 66666

SAMPLE RAW DATA:

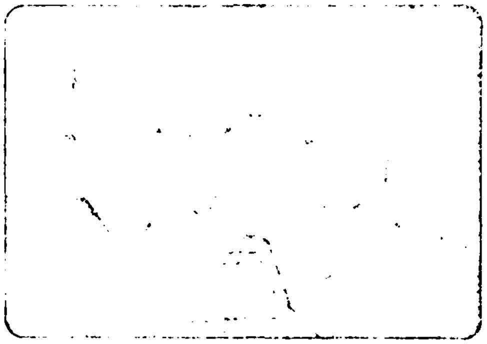
00050	20205, 00050
00100	30305, [illegible]
00150	20205, [illegible]
00200	30101, 00070
00250	30401, 00075
00300	30101, [illegible]
00350	40101, [illegible]
00400	20101, 00001

etc.

Stranger (person No. 5) speaks to child (focal subject), child responds by freezing, staring and showing fearful countenance; stranger speaks again, child turns and gestures to mother (person No. 1) with distressed countenance; child approaches mother; child clings to mother's leg; mother pats child's head and speaks in soothing voice.

SOCIAL INTERACTION IN SMALL GROUPS*

by: Rand D. Co[illegible], Ph.D.
Doug Mc[illegible], Ph.D.
Department of Sociology
University of Georgia
Athens, Georgia 30602



ANALYSIS:

This study measures frequency, duration and rate of behavior in small groups.

SOFTWARE:

Written in BASIC
NOS Text Editing
SPSS

HARDWARE:

T. I. 733 ASR
CDC CYBER 70, Model 74
IBM 370, Model 158

ABSTRACT:

This study is designed to investigate behavior in human groups. The behavior code is based on a systematic sample of the group members with respect to verbal and physical contacts, emotional affects, commands and compliance, and the two people communicating. The parameters for the analysis and description of regularities in the data suggestive of causal relationships are: Frequencies and rates of behavior, reciprocity, equity, S-R type interacts and sequential dependencies. Data are recorded in the natural setting for whatever the task of the small group happens to be.

*A complete description is published in "Behavior Research Methods & Instrumentation," 1977, Vol. 9 (5), 419-424.

CODING SCHEME

One digit only = Focal Subject

Type of Interaction (1st digit)
- Verbal give 1
- Verbal receive 2
- Physical give 3
- Physical receive 4

Emotional Affect (2nd digit)
- Neutral 1
- Positive 2
- Negative 3

Other Actor (3rd & 4th digits)
- Person one 01
- Person x . . . . to 99

Commands Compliance (5th digit)
- Prescriptive command 1
- Proscriptive command 2
- Comply 3
- Refuse 4
- None of these 5

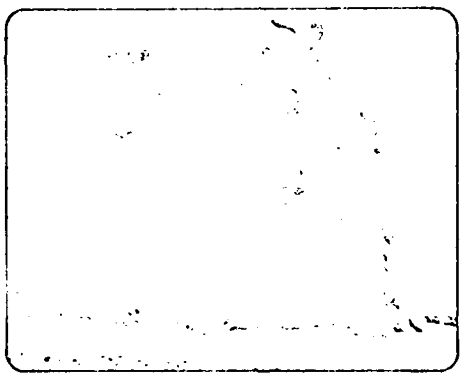
New Focal Subject = 99999
End of Session = 77777

SAMPLE RAW DATA:						
	00050	1	99999	[illegible]	[illegible]	[illegible]
	00100	11025	[illegible]	[illegible]	4	[illegible]
	00150	21025	[illegible]			
	00200	33025	[illegible]		etc.	
	00250	41025	[illegible]			
	00300	12025	[illegible]	[illegible] 1	39999 [illegible] 1	
	00350	22025	[illegible]	[illegible]	77777 [illegible]	

NON-HUMAN PRIMATE BEHAVIOR

by: Paul Heltne, Ph.D.
Johns Hopkins University
Baltimore Zoological Society
Baltimore, Maryland 21205

Pearce Johnson
Johns Hopkins University



ANALYSIS:

This study examines behavior of the endangered species, Macaca silenus, for occurrence, direction, frequency, duration and sequence, and for changes in these parameters during infant development.

SOFTWARE:

FASTIN, SOS (Harvard), SPSS

HARDWARE:

Digital Equipment DEC 10
Research Inc., CRT Terminal

ABSTRACT:

This study examines the behavior of a breeding troop of wanderoo monkeys (Macaca silenus) at the Baltimore Zoo. One purpose of the research is to recognize normal patterns of behavioral development. Rearing behaviors of both dominant and subordinate mothers are also being compared. This study will support successful captive breeding programs which are essential if this endangered species is to be saved from extinction. The [illegible] are recorded in a coded sentence format: Subject (and modifiers), verb, ob, ct (and modifier) and context. The subject and verb are necessary for each entry, while modifiers (parts of body or environment) and objects are optional. An asterisk always precedes the verb code so that portions of the code can be separated into appropriate columns for subsequent analysis. The coding system has proven to be flexible and easy to learn. It can be adapted easily to detailed behavioral studies of a wide range of animals.

CODING SCHEME:

Subjects and Objects (2 digits) = Animals (C, F or H with 1-4, as F3)

(C=toward) - (F=away)

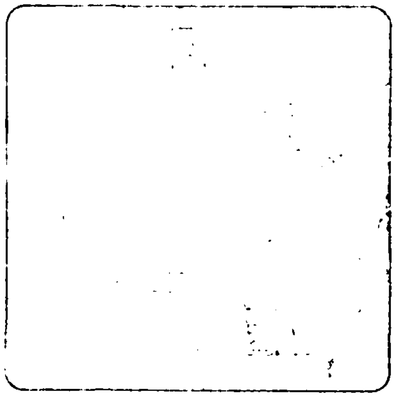
Verbs
- Neutral 0C-9C
- (Motion) 0F-9F
- (Motion) 10-14
- Stationary 15-29
- Approach 30-39
- Dominance 40-49
- Vocalization 50-59
- Sexual 60-63
- Infant 70-91
- Facial C0-C7
- Facial H0-H5
- Feeding F0-F6
- Modifiers . . . . . 00-39,93-95 (e.g. parts of body, cage, etc.)
- Context . . . . C,F,H,1-8 (one alphanumeric to indicate play, disturbance, sexual, etc.)

SAMPLE RAW DATA:

F1*12,00000 F1 runs around cage at 000.00 minutes elapsed time
C103*0CF2003,000.27 C1 puts hands to F2's head in response to previous sequence, at 000.27.
H2*40F3,00043 H2 grabs F2, at 000.43
F1*61C1H,00079 F1 mounts C1 sexually, at 000.79
F103*0CH2076,00061 F1 puts hand to H2's foot gently, at 000.61

INFANT VISUAL BEHAVIOR*

by: [illegible], Ph.D.
[illegible]
University [illegible]
Miami, Florida 33136
Wendi, [illegible]
Nova University



CODING SCHEME:

Header Data	[illegible]
Subject number	1-22*
Full term or premature	1,2*
Female or male	1,2*
Session number	1,2
Trial Header Data	C
Trial number	1-8
Mother or stranger	1,2
Study Data	
Visual fixation on mother	1
Eyes closed	2
Looking away	3
Visual fixation on other stimuli	4

ANALYSIS:

This study measures the durations, frequencies and mean times of infant visual behavior.

SOFTWARE:

Self developed program

HARDWARE:

ModComp II Minicomputer with disk storage

ABSTRACT:

This study measures the duration of various infant visual behaviors in order to compare the social [illegible] of premature and full term infants. Videotape recordings are made of the four infant groups: premature females and males, and full term females and males, responding to their mothers and to a stranger. Data are obtained during two sessions of eight trials each. Four dependent measures are scored: Duration of fixation on mother or stranger, closing eyes, looking away, and time to first fixation on the stimuli. Whenever a behavior begins, a number (1-4, corresponding to the [illegible] coding system) is recorded. This same number is recorded at the end of the behavior. The program then subtracts the time recorded at the second occurrence from the time recorded at the first occurrence to determine total time for the behavior.

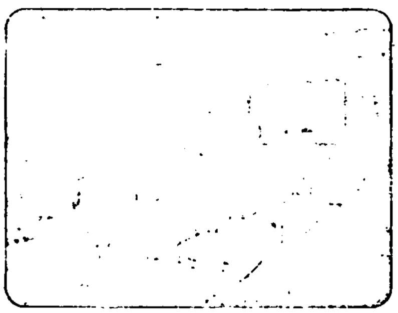
SAMPLE RAW DATA:

H26*2*1*1*[illegible]
C62
2,000[illegible]
2,00[illegible]
1,0[illegible]
1,00[illegible]
3,00[illegible]
3,00[illegible]

*A more complete description, with program listing, is published in "Behavior Research Methods and Instrumentation", 1977, [illegible] (5), 429-433.

MEMBER INTERACTION IN A LARGE SPONTANEOUS GROUP*

by: Richard E. S[illegible], Ph.D.
Department of S[illegible]
University of Minnesota
Minneapolis, Minnesota 55455



CODING SCHEME:

Header Data	Date, time, etc.
Sample Areas	Two [illegible] characters preceded by C
F 100	Sample [illegible]
Subjects	Two [illegible] characters preceded by F
F	S(s) present [illegible] not in[illegible]
H	S(s) [illegible]
99	Group [illegible]

ANALYSIS:

This study measures the frequency of interaction and emergent patterns of informal groups among Navy recruits.

SOFTWARE:

Self-Developed
CDC - XEDIT *Program*
SPSS

HARDWARE:

CDC
TELETYPE

ABSTRACT:

This study examines social psychological variables which precipitate the formation of informal friendship networks among Navy recruits, including proximity and similarity. Subject interaction was sampled by observers in the classroom, mess and barracks. Interaction frequencies among all members of the approximately 40 man company [illegible] [illegible] identifiers of [illegible] within a sampled area, identifiers of [illegible] in the same area, and identifiers of empty areas. The results indicate that most recruits interact primarily with recruits in adjacent beds. When given a choice, they will interact with adjacent recruits who are similar in color, religion and education. Overt hostility toward dissimilars was rare.

SAMPLE RAW DATA

C7,01710	22,01[illegible]
F17,01765	32,01[illegible]
C3,01891	C[illegible]
F11,01894	H3[illegible]
14,01887	5,01[illegible]
12,01889	F12,01[illegible]74
H20,01894	33,01[illegible]

*A more complete description is published in "Behavior Research Methods and Instrumentation", 1977, Vol. 9 (5), 407-417.

PARENT-INFANT INTERACTIONS*

by: Douglas B. Sawin, Ph.D.
Judith H. Langlois, Ph.D.
Edward F. Leitner, B.A.

Department of Psychology
University of Texas
Austin, Texas 78722

CODING SCHEME:

Actor (first digit)
- Infant 1
- Mother 3
- Father 7

Class of Behavior (2nd digit)
- Holding positions 1
- Visual activities 2
- n x

Specific Behavior (3rd digit)
- Adjusts feeding 1
- Eye contact 2
- n x

Type of Entry (4th digit)
- Onset 1
- Termination 0
- Single Occurrence 2

ANALYSIS:

This study measures the frequency, duration and sequence of parent and infant behaviors, and conditional probability estimates of contingencies among behaviors in parent-infant interactions.

SOFTWARE:

BABES – Error check program and derivation of frequencies and durations.

CPB -- Conditional and baseline probabilities program.

HARDWARE:

CDC 6600-6400

ABSTRACT:

This is a longitudinal study of parent-infant interactions and infant development over the first year of infant life in a sample of Black, Mexican-American and Anglo-American families. The amount of stimulation and affection provided by the parents to the infants, the sensitivity and responsiveness of the parents to infant cues, and the responsiveness of the infants to the parents are measured. Factors in the analyses of the behavioral data will include sex of parent, sex and age of infant, ethnic group, and parent and infant temperaments. Data have been obtained during observations of the parents and infants in the hospital within 72 hours of birth, and at successive three month intervals through the ninth month of infant life. Preliminary analyses of early data indicate that while there were no significant differences in the number of times that mothers in the three ethnic groups adjusted the way they held their infants, the conditional probability analyses revealed that Black mothers were more likely than mothers in the other two groups to adjust their feeding pattern contingent upon distress signals (negative vocalizations) from the infants.

*A complete description is published in "Behavior Research Methods & Instrumentation," 1977, Vol. 9 (5) 425-428.

SAMPLE RAW DATA:

```
00100  3130,  00006
00110  3602,  00012
00120  1621,  00014
00130  3720,  00026
00140  3311,  00114
00150  1211,  00118
00160  1344,  00124
```

TEACHER-PUPIL CLASSROOM INTERACTION

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A. E. Lott, Director
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CODING SCHEME:

(Input Mode 2. One character autotime)

- 0
- 1 (P) Talk
- 2 (P) Low level response
- 3 (P) High level response
- 4 (P) No response
- 5 (T) Talk
- 6 (T) Low level question
- 7 (T) High level question
- 8 (T) Positive feedback
- 9 (T) Negative feedback
- C Incorporate context
- F No interaction
- H Interruption

ANALYSIS:

This project measures frequency and duration of teacher-pupil interaction and identifies sequences and patterns of behavior.

SOFTWARE:

Written in BASIC

HARDWARE:

DEC SYSTEM 10

SAMPLE RAW DATA:

```
H, 00000    7, 00027
5, 00005    3, 00030
6, 00011    8, 00033
2, 00015    7, 00042
8, 00018    F, 00045
```

GOAL:

This project was designed to provide teachers with feedback for training purposes. A classroom observer recorded teacher-pupil interaction data with the DATAMYTE 900 and the results were sent directly to the computer for instant analysis. Within twenty minutes, many of the teachers received the feedback so that they could discriminate, generate and objectively evaluate specific teaching strategies.

INSERVICE TEACHER TRAINING FOR DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF PUPIL SOCIO-BEHAVIORAL I.E.P. OBJECTIVES

by: Melvyn Semmel, Ph.D.
Keith Brownsmith, Ph.D.
Ted Hasselbring, Ph.D.
Ida Blotcky, M.S.

Center for Innovation in Teaching the Handicapped (CITH)
Indiana University
Bloomington, Indiana

Board of Cooperative Educational Services
Pines Bridge School
Yorktown Heights, New York 10598

ANALYSIS:

This project measures the frequency, percent time and rate per minute of pupil teacher interactions within the classroom environment for moderately and severely retarded pupils.

SOFTWARE:

General Electric Extended FORTRAN

HARDWARE:

General Electric Mark III
Texas Instruments Model 745

ABSTRACT:

This project was designed as one of five modules in an inservice teacher training package. Its purpose is to assist teachers of the moderately and severely retarded to systematically alter pupil maladaptive social behavior. Data collection occurs within the classroom environment. A trained observer coder collects pupil teacher interactive data which is based on a systematic observation system via the DATAMYTE. The data collected is then transmitted to the computer for analysis and storage. Upon completion of the baseline data collection phase, the teacher receives a baseline summary printout which is used to develop and implement an intervention strategy geared toward modifying unacceptable target behavior. Once the intervention phase is initiated, observations resume and the teacher receives daily summary feedback. This feedback enables the teacher to monitor the efficacy of the intervention strategy and to evaluate pupil progress.

CODING SCHEME:

Input Mode 1. Appended time intervals

PUPIL BEHAVIOR

Type of Interaction (1st digit)
- Appropriate 1
- Inappropriate 2

Mode (2nd digit)
- Verbal physical 1
- Verbal 2
- Physical 3
- Non verbal 4
- Passive 5

Focus (3rd digit)
- Adult 1
- Peer 2
- Object 3
- Self 4

TEACHER BEHAVIOR

Type of Interaction (1st digit)
- Neutral 3
- Approval 4
- Disapproval 5

Mode (2nd digit)
- Verbal physical 1
- Verbal 2
- Physical 3
- Non-verbal 4
- Passive 5

Situational Categories
- Activity 6 (1-10)
- Teacher I.D. 7 (1-99)
- Task 8 (1-2)

SAMPLE RAW DATA:

000001, 00000
221, 00003
69, 00007
050278, 00012
0950, 00014

BEGIN SESSION

0011, 00016
62, 00017
769, 00018
81, 00019
35, 00022
154, 00025
32, 00028
234, 00030
52, 00032
151, 00036
41, 00040

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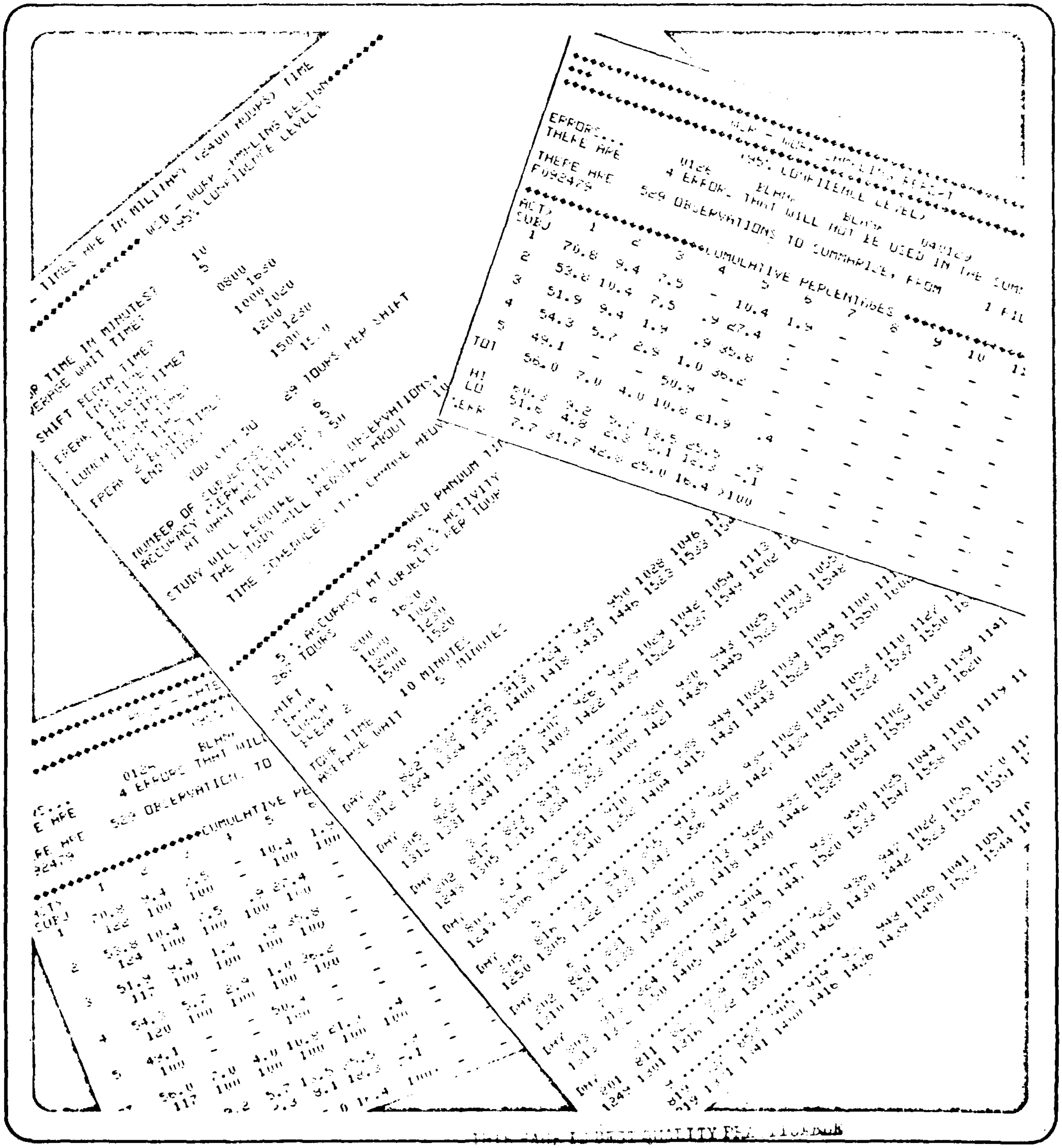
153 BULLETIN

WS WORK SAMPLING PROGRAMS FOR DATAMYTE® 1000 DATA COLLECTOR



THE WS PACKAGE

The WS package comprises a User Manual plus well documented Source Listings — in Basic — for three computer programs:

WSD (Work Sampling Design) — Aids in estimating a study; then prints a random time schedule if desired.

WSR (Work Sampling Report) — Summarizes unrated observations.

RWSR (Rated Work Sampling Report) — Summarizes rated observations.

These programs accommodate up to 14 activities for up to 40 subjects, unlimited total observations, fixed or random interval. A treatise on the statistical criteria employed is included in the User Manual.

THE WS CONCEPT

The study is first estimated using the WSD program. Observations are then taken using the Datamyte 1000, and transmitted to a computer daily. A WSR (or RWSR) report can be printed daily to assess current accuracy. When the required accuracy has been achieved, the study is finished.

OBSERVATION CODES

Observations can be recorded two ways — unrated or rated:

UNRATED: Each unrated observation is recorded as a 4-digit code.

```
                  XX  XX
Subject (01-40) ───┘   │
Activity (01-14) ──────┘
```

RATED: Each rated observation is recorded as a 7-digit code:

```
                  XX  XX  XXX
Subject (01-40) ───┘   │    │
Activity (01-14) ──────┘    │
Rating (000-999%) ──────────┘
```

Both unrated (4-digit) and rated (7-digit) observations can be mixed in a study.

OTHER CODES

F-CODE: A block of observations — one day, one shift, even one tour — can be identified by up to eight characters preceded by an F. For example, F072779*2 could indicate July 27, 1979, Shift 2. The WSR report shows all file numbers that are summarized. Various file-numbered blocks can be combined for selective data processing if desired.

C-CODE: Comments can be included in the raw data by prefixing up to four characters with a C to indicate tour begin time, for example. Thus, C1430 indicates a tour began at 2:30 pm. The WSR report ignores all C Codes, but the entry is a permanent part of the raw data.

DESIGNING A WS STUDY

The following parameters are typed into the WSD (Design) program in response to prompts. Time-of-day is entered in military (2400 hours) time:

TOUR TIME: The time, in minutes, to walk a full tour and return to the begin point.

AVERAGE WAIT: The average minutes-between-tours.

SHIFT: The begin and end times for the shift.

BREAKS, LUNCH: The begin and end times for two breaks and lunch.

WSD now calculates the number of tours per day that are possible. You can elect to go on or go back to the beginning.

The next parameters are as follows:

NUMBER OF SUBJECTS: The number of people or machines on the tour.

DEVIATION RANGE: Confidence level, in standard deviations.

ACCURACY (ERR%): The 95% confidence accuracy desired.

ACTIVITY %: The percent activity at which the above accuracy is desired.

WSD now calculates the number of observations needed, and the tours needed, to satisfy the accuracy specified. The number of days required to take the data is also estimated. At this point you can (1) go back and change the accuracy criteria, or (2) print a random time schedule, or (3) quit. If the study is to be fixed interval, you would quit. If the study is to be random interval, you would print a time schedule.

The random time schedule will print tour schedules calculated not to interfere with breaks or lunch. The average wait is doubled, then randomized to determine these times. Thus an average wait of 10 minutes will be randomized from 0 to 20 minutes, then added to the tour time to determine the next

interval. The schedule is divided into days — DAY 1, DAY 2, etc.

TAKING A WS STUDY

The Datamyte 1000 is set to IN-MODE 5 and an optional file number entered (e.g., F072779*2).

Each tour can begin by entering an optional begin time with the comment code (e.g., C1430). Observations are then entered as 4-digit (unrated) or 7-digit (rated) codes, identifying the subject (01-40), activity (01-14), and the rating (000-999%). The next tour can begin with an optional comment code. Up to 40 subjects can be sampled per tour; up to 14 activity codes can be used. An unlimited number of observations can be accommodated by the WSR and RWSR programs. The Datamyte itself is limited to about 1000 unrated or 575 rated observations per 4K memory (e.g., a 16K Datamyte will hold about 4000 unrated or 2300 rated observations).

PROCESSING A WS STUDY

The Datamyte is plugged into a computer terminal or minicomputer by means of a simple interface cable and the data is dumped. Data is combined with data from previous day's observations. The WSR or RWSR program is then executed, producing a printed summary report. The whole process takes about 5 minutes.

The programs first go through all the data looking for invalid entries. All such entries are printed, as "errors". Next, the file numbers of all the blocks of data being summarized are printed.

Then the programs print the percent activities by subject, and the total number of observations for each subject. Finally, percent activities for the entire population are printed, plus high and low limits (percent activity plus and minus two standard deviations), and the statistical accuracy (two standard deviations divided by the percent activity).

The RWSR program also shows the composite ratings for every activity for every subject, plus overall subject, activity and study ratings.

Typically, a report would be run daily on the cumulative data to date. As soon as the desired accuracy (ERR%) has been achieved on a specified activity, the study is finished. The last report portrays the percent activities to be used. The percent activities can be used to determine allowances, to analyze workloads, to audit standards, etc.

SUITABLE COMPUTERS

You can rewrite the programs for almost any computer that supports BASIC. A computer with at least 16K memory is desirable.

The computer must have at least an 80-column printer and it must be able to interface with the Datamyte which transmits serial ASCII into RS232C or 20ma inputs.

```
NOTE...ALL TIMES ARE IN MILITARY (2400 HOURS) TIME
************************ W.D - WORK SAMPLING DESIGN

TOUR TIME IN MINUTES?        10
AVERAGE WAIT TIME?           5

SHIFT BEGIN TIME?            0800
      END TIME?                1630
BREAK 1 BEGIN TIME?          1000
      END TIME?                1020
LUNCH BEGIN TIME?            1200
      END TIME?                1230
BREAK 2 BEGIN TIME?          1500
      END TIME?                1520

        YOU CAN DO     29 TOURS PER SHIFT

NUMBER OF SUBJECTS?          6
ACCURACY (%ERR) DESIRED?     5
    AT WHAT ACTIVITY % ? 50

STUDY WILL REQUIRE  1600  OBSERVATIONS,    267 TOUR
    THE STUDY WILL REQUIRE ABOUT     10 DAYS

    TIME SCHEDULES (T), CHANGE ABOVE (C), OR QUIT


****************************WSD RANDOM TIME SCHEDULE

   5 % ACCURACY AT     50 % ACTIVITY
 267 TOURS       6 SUBJECTS PER TOUR

SHIFT          800    1630
 BREAK 1       1000    1020
 LUNCH         1200    1230
 BREAK 2       1500    1520

TOUR TIME     10 MINUTES
AVERAGE WAIT       5  MINUTES

DAY      1 ........................
  809   822   838   856   913   924   939   950  1023  104
 1312  1324  1334  1347  1400  1418  1431  1446  1523  153

DAY      2 ........................
  805   822   840   853   907   926   939  1029  1046  105
 1312  1331  1341  1351  1408  1422  1439  1522  1537  154

DAY      3 ........................
  802   817   833   843   857   909   920   930   943  102
 1248  1305  1315  1334  1350  1409  1421  1435  1445  152

DAY      4 ........................
  809   824   836   851   910   926   938   949  1022  103
 1249  1306  1322  1340  1352  1404  1415  1431  1443  152

DAY      5 ........................
  805   816   831   843   850   912   923   939  1028  1041
 1250  1305  1322  1333  1343  1356  1409  1426  1439  145

DAY      6 ........................
  802   820   831   850   903   913   928   936  1019  104
 1310  1321  1338  1348  1406  1418  1430  1442  1529  154

DAY      7 ........................
  803   813   824   839   849   904   916   933   950  10
 1313  1332  1350  1405  1422  1435  1447  1520  1532  154

DAY      8 ........................
  801   811   828   839   850   901   923   936   947  102
 1249  1301  1316  1332  1351  1405  1420  1430  1442  152

DAY      9 ........................
  806   819   837   853   905   919   930   948  1026  104
 1306  1319  1331  1341  1400  1416  1426  1439  1450  152
```

Figure 1. WSD (Work Sampling Design) Printout

WSR - WORK SAMPLING REPORT — PROGRAM 11.01

(95% CONFIDENCE LEVEL)

ERRORS... 0126 BLANK BLANK 040129
THERE ARE 4 ERRORS THAT WILL NOT BE USED IN THE SUMMARY

THERE ARE 529 OBSERVATIONS TO SUMMARIZE, FROM 1 FILES:
F092479

CUMULATIVE PERCENTAGES

ACT> SUBJ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OBS
1	70.8	9.4	7.5	-	10.4	1.9	-	-	-	-	-	-	-	-	106
2	53.8	10.4	7.5	.9	27.4	-	-	-	-	-	-	-	-	-	106
3	51.9	9.4	1.9	.9	35.8	-	-	-	-	-	-	-	-	-	106
4	54.3	5.7	2.9	1.0	36.2	-	-	-	-	-	-	-	-	-	105
5	49.1	-	-	50.9	-	-	-	-	-	-	-	-	-	-	106
TOT	56.0	7.0	4.0	10.8	21.9	.4	-	-	-	-	-	-	-	-	529
HI	60.3	9.2	5.7	13.5	25.5	.9	-	-	-	-	-	-	-	-	
LO	51.6	4.8	2.3	8.1	18.3	-.1	-	-	-	-	-	-	-	-	
%ERR	7.7	31.7	42.8	25.0	16.4	>100	-	-	-	-	-	-	-	-	

RWSR - RATED WORK SAMPLING REPORT — PROGRAM 10.01

(95% CONFIDENCE LEVEL)

ERRORS... 0126 BLANK BLANK 040129
THERE ARE 4 ERRORS THAT WILL NOT BE USED IN THE SUMMARY

THERE ARE 529 OBSERVATIONS TO SUMMARIZE, FROM 1 FILES:
F092479

CUMULATIVE PERCENTAGES & RATINGS

ACT> SUBJ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OBS RT
1	70.8	9.4	7.5	-	10.4	1.9	-	-	-	-	-	-	-	-	106
	122	100	100	-	100	100	-	-	-	-	-	-	-	-	116
2	53.8	10.4	7.5	.9	27.4	-	-	-	-	-	-	-	-	-	106
	124	100	100	100	100	-	-	-	-	-	-	-	-	-	113
3	51.9	9.4	1.9	.9	35.8	-	-	-	-	-	-	-	-	-	106
	117	100	100	100	100	-	-	-	-	-	-	-	-	-	109
4	54.3	5.7	2.9	1.0	36.2	-	-	-	-	-	-	-	-	-	105
	120	100	100	100	100	-	-	-	-	-	-	-	-	-	111
5	49.1	-	-	50.9	-	-	-	-	-	-	-	-	-	-	106
	100	-	-	100	-	-	-	-	-	-	-	-	-	-	100
TOT	56.0	7.0	4.0	10.8	21.9	.4	-	-	-	-	-	-	-	-	529
	117	100	100	100	100	100	-	-	-	-	-	-	-	-	110
HI	60.3	9.2	5.7	13.5	25.5	.9	-	-	-	-	-	-	-	-	
LO	51.6	4.8	2.3	8.1	18.3	-.1	-	-	-	-	-	-	-	-	
%ERR	7.7	31.7	42.8	25.0	16.4	>100	-	-	-	-	-	-	-	-	

Figure 2. WSR and RWSR Printouts

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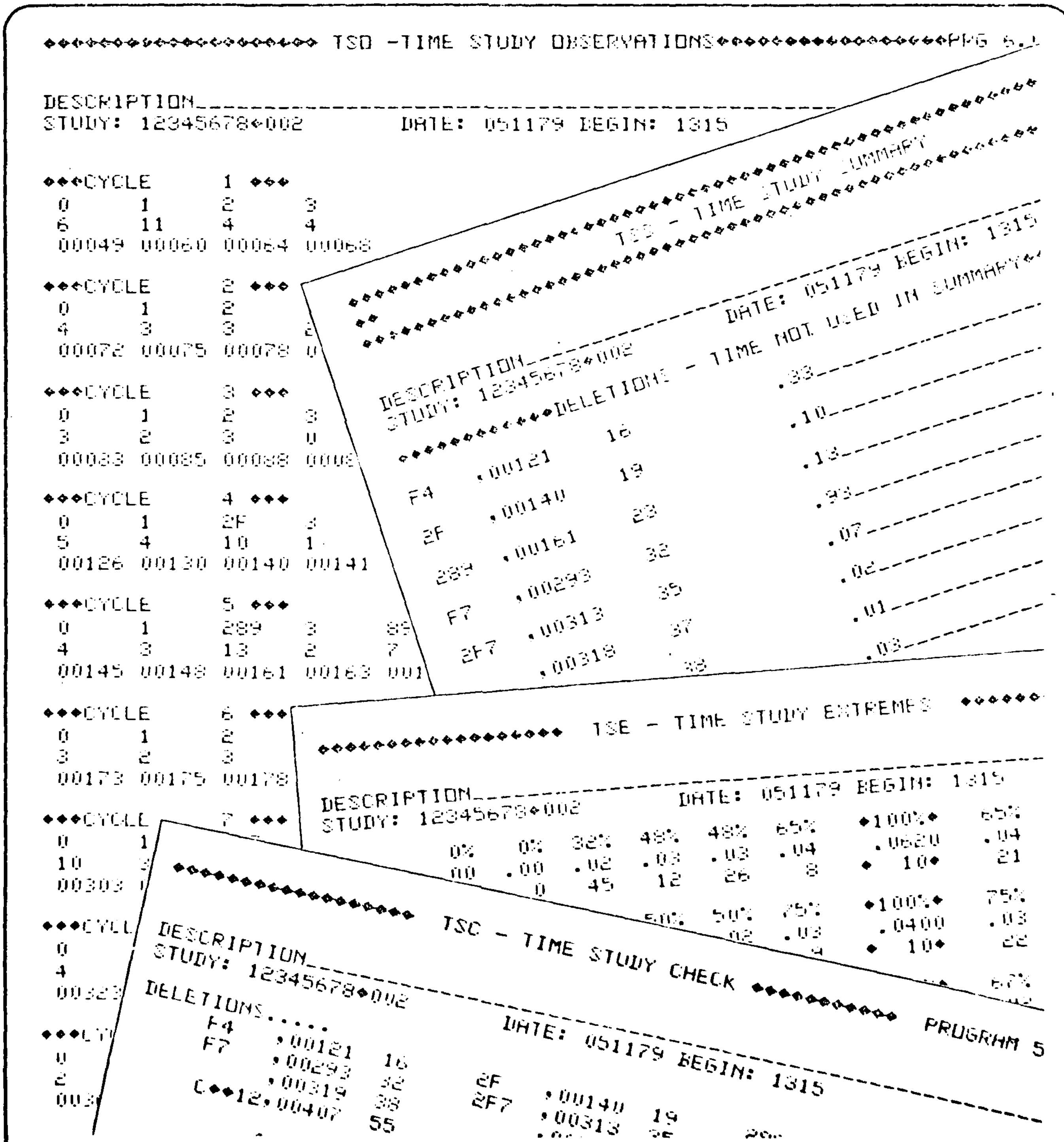
BULLETIN

TS TIME STUDY PROGRAMS FOR DATAMYTE® 1000 DATA COLLECTOR



THE TS PACKAGE

The TS programs are four stand-alone computer programs for use in performing computer-aided time studies using the Datamyte 1000 and a computer.

The TS package comprises a User Manual describing how to design a TS time study and how to use the Datamyte, and source listings in BASIC computer language, with documentation, for all four programs.

All four programs — TSC, TSE, TSO and TSS1 — will be described later. But first a word about the TS concept and taking a TS study.

THE TS CONCEPT

The operation to be studied is first divided into elements and a code number assigned to each. Elements may be pre-described, or described as they occur and written on the scratch pad.

ELEMENT CODES

Elements fall into two classifications:

SUMMARY: Such elements, usually including routine work elements and non-cyclics, will be summarized. Up to 100 descriptions, codes 0-99, can be used. The 0 (zero) code is used to indicate the beginning of a cycle, as are codes 01-09.

DELETIONS: These are likely to include foreigns, abnormal work elements, and work elements with either imbedded foreigns or imbedded non-cyclics. Such elements (all number codes above 99 and all with F or H) will be deleted . . . not used in the calculations.

OTHER CODES

C CODE: Entries with a C prefix will not be recognized by the TS programs as anything other than "comments" . . . to note number of pieces per batch, or for flagging certain observations for review, etc. (You may want to modify the TS programs to include comment codes in the calculations.)

ASTERISK (*) CODE: This prefix code is used for leveling or rating. You can enter pace ratings at any time during the study and rate all observations back to the last pace rating entered. Even individual observations may be rated using this method. Element ratings may be entered at the end of the study to level all occurrences of a specific element code. Either pace rating or element rating, or both, may be used in a study. If both are used, the rating factors multiply each other.

HC CODE: A piece count of up to 9999 pieces may be entered at the end of the study, prefaced by code HC.

C SUFFIX: Element codes with a C suffix will be treated as continuations (rather than repeats) of the element in the TSS1 report, permitting an element to be interpreted by a foreign, then resumed.

TAKING A TS TIME STUDY

First, set the Datamyte 1000 (any model) to IN-MODE 1, data-plus-time. Then key in a STUDY IDENTIFICATION code of up to 12 characters (e.g., 01,12345678*003, etc.), a 6-character DATE (e.g., 060979) and a 4-character BEGIN TIME (e.g., 0830).

Key the first element code during the course of the element; then key ENTER exactly at the breakpoint. Key subsequent elements as they happen, followed by ENTER each time at the breakpoint. Enter foreigns and non-cyclics as they occur, and comment codes as necessary.

Pace ratings (optional) can be entered at any time . . . the end of the study, hourly, after every observation, etc. Element ratings and a piece count (both optional) are entered at the end of the study.

An unlimited number of observations can be accommodated by the TS programs. However, the Datamyte itself is limited to about 500 observations per 4K memory (e.g., a 16K Datamyte will hold about 2000 observations).

PROCESSING VIA TS PROGRAMS

The Datamyte 900 is plugged into a computer terminal or minicomputer by means of a simple interface cable and the data is dumped. One of the following TS programs is executed and the data processed almost instantly, with no questions to answer.

When all four programs are used, this is a typical sequence:

TSC (TIME STUDY CHECK): This small program (less than 3K in BASIC) looks for all missing codes, deletions, comments, summary observations (and whether pace rated and/or element leveled), cycles and the piece count . . . then prints out a short tally for your review. At this point, errors can be spotted and corrected, using the computer's edit function, before running the longer reports. Since the printout is short, execution time is fast.

TSE (TIME STUDY EXTREMES): This program (about 4K in BASIC, plus .1K per element code

used) prints out the average, plus the six longest and six shortest observations for each summary element code. It also prints out a percentage above or below average for quick reference, and the location of each observation as an aid in editing. By using the computer's edit function, any highly abnormal observation can be changed to a DELETION before running any lengthy reports.

TSO (TIME STUDY OBSERVATIONS): This program (less than 4K in BASIC) prints out every observation in the study . . . element code, elapsed time and readpoint time. If the study is cyclical, the observations are divided into cycles. A short tally, identical to TSC, prints at the bottom. This report provides a computerized spread sheet similar to the work sheet used in stopwatch studies, and it is the backup documentation to the TSS report.

```
******************** TSO -TIME STUDY OBSERVATIONS*********

DESCRIPTION...  ___ _______________________________________
STUDY: [illegible]                DATE: 010430 BEGIN: [illegible]

***CYCLE      1 ***
 01    2     3     94    5     6     7     81
 7     41    6     12    4     15    2     3
 [illegible] [illegible] [illegible] [illegible] 00093 00102 00110 00113

***CYCLE      2 ***
 01    2     3     44    5     6     7     81
 3     41    5     12    3     15    3     15
 00121 [illegible] [illegible] [illegible] [illegible] [illegible] 00201 00216

***CYCLE      3 ***
 01    2     3     94    5     6     7     81
 10    40    5     13    4     14    4     9
 [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] 00315

***CYCLE      4 ***
 01    2     3     94    5     6     7     81
 11    34    6     13    4     15    2     14
 [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] 00405 00419

***CYCLE      5 ***
 01F1  2     3     94    5     6     7     C1    81
 124   40    5     12    4     15    2     CMNT  88
 00543 [illegible] [illegible] [illegible] [illegible] [illegible] 00621 00694 [illegible]

***CYCLE      6 ***
 01    2     3     94    5     6     7     81
 11    34    5     13    4     15    3     96
 00720 00759 00764 [illegible] [illegible] [illegible] 00799 [illegible]

***CYCLE      7 ***
 01    2     3     94    5     6     7     81
 13    31    2     9     3     14    3     16
 [illegible] 00941 [illegible] 00952 00955 [illegible] 00972 [illegible]

***CYCLE      8 ***
 01    2     3     94    5     6     7     81
 12    31    2     11    4     14    2     16
 01000 [illegible] [illegible] 01044 01048 [illegible] 01064 [illegible]

***CYCLE      9 ***
 01    2     3     94    5     6     7     81
 13    28    5     11    4     14    2     14
 [illegible] 01121 [illegible] 01137 01141 01155 01157 01171

***CYCLE     10 ***
 01    2     3     94    5     6     7     81
 12    29    4     12    3     14    2     13
 01193 01212 [illegible] [illegible] [illegible] 01245 01247 01260

***CYCLE     11 ***
 01    2     3     94    5     6     7     81
 12    31    2     13    3     14    2     13
 01272 [illegible] [illegible] [illegible] [illegible] 01335 [illegible] 01350

***CYCLE     12 ***
 01    2     3     94    5     6     7     81
 12    [illegible] 4  12    4     14    2     23
 [illegible] 01391 [illegible] 01407 01411 01425 01427 01450

***CYCLE     13 ***
 01    2     3     94    5     6     7     81
 12    30    4     12    3     14    3     13
 [illegible] 01492 [illegible] 01503 01511 01525 01528 01546
```

TSO Report — Showing a cyclical study

TSS1 (TIME STUDY SUMMARY): This program (about 6K plus .05K per element code used) yields the normal element times. It first removes all DELETIONS and prints them. Next, for all SUMMARY elements, it prints out a final summary that shows the rating, minimum, maximum, average and normal (rated) element times. If the study includes cyclical (0) codes, a normal time per cycle is shown, and if a piece count is included, a normal time per piece is also shown.

A final job standard can be quickly assembled manually, just as you now do it, using your own method of including allowances, machine times, frequency adjustments and conversions to pieces/hour, minutes/piece, etc. Or, you can add a few statements to the TSS program and let the computer do it.

SUITABLE COMPUTERS

You can rewrite the TS programs for almost any computer of 8K memory or larger that supports BASIC. The computer must have at least an 80-column printer, and it must be able to interface with the Datamyte which transmits serial ASCII into RS232C or 20 ma inputs.

If you do not have access to a computer, the TS programs can be accessed on a low cost service bureau time-share system, using almost any time-share terminal. The cost is only about one-fourth the cost of most other time-share systems, and the system has local telephone access in all major cities.

WANT TO TRY IT OUT?

The TS programs can be tried out on the time-share system. You'll need a Datamyte, a battery charger, an interface cable and a time-share computer terminal. There is a one-time charge per corporation for the TS package; the programs and documentation are yours to keep.

Refer to the Datamyte 1000 price list for purchase or lease details.

```
******************  TSC - TIME STUDY CHECK  ***********  [illegible]

DESCRIPTION.______________________________________________
STUDY: [illegible]             DATE: [illegible] BEGIN: [illegible]

DELETIONS.....
      01F1 +00543     C1    +00694     C2    +01312

           0 MISSING CODES
           1 DELETIONS
           2 COMMENT
         227 OBSERVATIONS (NO PACE RATINGS, ELEMENT LEVELED)
              [illegible] CYCLES
              28 FIELDS
```

TSC Report — Showing comments, deleted observations, and tally

******************* TSE - TIME STUDY EXTREMES **************** PROGRAM 6.02 **

DESCRIPTION____
STUDY: 170*1 * * DATE: 0104[illegible] BEGIN: 0750

	53%	[illegible]	[illegible]	91%	91%	*100%*	[illegible]	[illegible]	[illegible]	[illegible]	125%
1	.07	[illegible]	.10	.11	.11	.1204	.13	.13	.13	.13	.15
	30	131	[illegible]	[illegible]	[illegible]	* [illegible]*	2724	2875	[illegible]	[illegible]	[illegible]
	81%	84%	84%	84%	87%	*100%*	[illegible]	[illegible]	[illegible]	[illegible]	132%
2	.25	[illegible]	[illegible]	[illegible]	.27	.3100	[illegible]	.40	.40	.41	.41
	2930	[illegible]	[illegible]	2157	2617	* 29*	[illegible]	266	[illegible]	71	162
	45%	45%	45%	45%	45%	*100%*	135%	135%	135%	135%	135%
3	.02	.02	.02	.02	.02	.0445	.06	.06	.06	.06	.06
	1775	[illegible]	[illegible]	943	[illegible]	* 29*	77	371	2441	[illegible]	[illegible]
	81%	81%	81%	81%	81%	*100%*	108%	108%	108%	108%	108%
5	.03	.03	.03	.03	.03	.0371	.04	.04	.04	.04	.04
	2923	2273	[illegible]	1511	[illegible]	* [illegible]*	2551	[illegible]	2743	[illegible]	3011
	99%	94%	99%	94%	99%	*100%*	106%	106%	106%	106%	106%
6	.14	.14	.14	.14	.14	.1418	.15	.15	.15	.15	.15
	3025	[illegible]	[illegible]	2757	2652	* [illegible]*	[illegible]	193	403	613	[illegible]
	84%	84%	84%	84%	84%	*100%*	126%	126%	126%	[illegible]	167%
7	.02	.02	.02	.02	.02	.0239	.03	.03	.03	.03	.04
	3027	[illegible]	[illegible]	[illegible]	2472	* 28*	[illegible]	2375	2655	[illegible]	[illegible]
	12%	37%	37%	41%	49%	*100%*	94%	102%	[illegible]	[illegible]	[illegible]
81	.03	.09	.09	.10	.12	.2454	.23	.25	.88	.96	1.24
	113	[illegible]	315	2577	[illegible]	* [illegible]*	1450	[illegible]	[illegible]	695	[illegible]
	77%	77%	94%	94%	94%	*100%*	111%	111%	111%	111%	111%
94	.09	.09	.11	.11	.11	.1166	.13	.13	.13	.13	.13
	1602	952	3007	[illegible]	2452	* [illegible]*	284	384	777	1318	[illegible]

TSE Report — Showing longest and shortest observations

****
** TSS1 - TIME STUDY SUMMARY PROGRAM 6.0[illegible] **
****

DESCRIPTION____
STUDY: 170*12*6*30 DATE: 010480 BEGIN: 0750

*************DELETIONS - TIME NOT USED IN SUMMARY****************************

01F1.,00543 1.24__________________________________

TIME DELETED: 1.24

******************* SUMMARY ***

OBS	RAW	RATED	MIN	MAX	AVE	RATE	NRM CYC	NRM PCE	NRM OCC
1									.1324
28	3.3700	3.7070	.07	.15	.1204	110.0	.1272	.1324	
2									.2790
29	8.9300	8.0310	.25	.41	.3100	90.0	.2790	.2890	
3									.0445
29	1.2900	1.2900	.02	.06	.0445	100.0	.0445	.0461	
5									.0371
28	1.0400	1.0400	.03	.04	.0371	100.0	.0359	.0371	
6									.1489
28	3.9700	4.1685	.14	.15	.1418	105.0	.1437	.1489	
7									.0239
28	.6700	.6700	.02	.04	.0239	100.0	.0231	.0239	
81									.2454
28	6.8700	6.8700	.03	1.24	.2454	100.0	.2369	.2454	
94									.1166
29	3.3800	3.3800	.09	.13	.1166	100.0	.1166	.1207	
TOTALS						98.8%	29 CYC	28 PCS	

WARNING-NRM CYC INVALID FOR ELEMENTS WITH DELETIONS
WARNING-NRM PCE INVALID FOR ELEMENTS WITH DELETIONS

TIME USED: 29.58

TOTAL TIME: 30.82

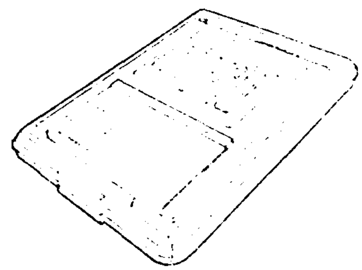
MACHINE TIME: .1166 AVE 29 CYC

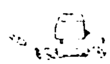
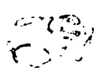
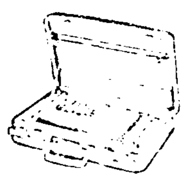
TSS Report — Showing minutes per occurrence, per cycle, and per piece.

DATAMYTE 1000 DATA COLLECTOR

[illegible]
MINNETONKA, MN 5534[illegible]

PRICE LIST [illegible]
Effective [illegible]
(Supersedes [illegible])
[illegible]

BASIC UNIT	BASIC MODEL NO.	DESCRIPTION	CAPABILITIES							UNIT PRICES NOTE: Add [illegible] BASIC MODEL NUMBER [illegible]					
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-4	-8	16	-32	[illegible]	[illegible]
	1004	Datamyte	X		X					$1640	$17[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1006	Datamyte	X		X	X	X			1740	18[illegible]	2100	[illegible]	3[illegible]	34[illegible]
	1001	Datamyte		X		X	X	X		1940	209[illegible]	[illegible]	2[illegible]	[illegible]	3[illegible]
	1002	Datamyte		X	X	X	X	X		2040	219[illegible]	24[illegible]	2[illegible]	[illegible]	37[illegible]
	1003	Datamyte		X		X	X	X	X	2140	2290	26[illegible]	30[illegible]	34[illegible]	3[illegible]

ACCESSORIES AND MISCELLANEOUS	PART NO.	DESCRIPTION	UNIT PRICES
Note: Required accessories for the Datamyte 1000 include a 71XX cable, battery charger, and spare battery.		Add memory later to above Datamyte models (per 8K increments)	$400
		Maintenance Agreement (One year period for each Datamyte and its operating accessories) a. If purchased [illegible]	200
		b. If purchased after initial warranty period	300
 CHARGER	1012	Battery Charger/AC Adapter (110V, 60Hz)	39
	1012A	Battery Charger/AC Adapter (220V, [illegible])	39
 AUTOMOTIVE ADAPTER	1013	Automotive Adapter (12V DC)	69
	1015	Spare Main Battery	49
 CARRYING CASE	1021	Datamyte Scratch Pads (per dozen)	9
	1022	Carrying Case (3" attache size)	59
 SPARE BATTERY	7122	Cable Adapter (1000 to 900 series)	39
	71XX	Interface Cable (see back side)	59
	TS-1	Time Study Computer Program	75
	WS-1	Work Sampling Computer Program	75

(1) **WITH ALPHANUMERIC CAPABILITY,** the alpha characters take twice the memory space of numeric characters. Therefore, the usable memory is determined by the ratio of alpha entries to numeric entries.

(2) **SERIAL INTERFACE.** Permits automatic recording of data from any external device that [illegible] RS 232 ports, or 20mA current loop [illegible] scales, micrometers and other instruments.

(3) **QUANTITY DISCOUNTS.** The following apply to all Datamyte models and accessories: [illegible]

(4) **LEASES.** [illegible] tend to fluctuate, check with [illegible] for the latest rate.

(5) **64K MEMORY.** Available by second quarter, 1981.

(6) **MAINTENANCE AGREEMENT.** Provides 12 months of service [illegible] operating [illegible] the [illegible] 90 day warranty [illegible] and surface transportation. (Complete details are covered on the MAINTENANCE AGREEMENT form.)

PURCHASE TERMS: Net 30 Days. F.O.B. Minnetonka, Minnesota.

WARRANTY: Covers parts, labor and surface transportation for a period of 90 days after [illegible]

SHIPPING WEIGHT:
Datamyte, Charger, Spare Battery, Interface Cable . . . . 12 lbs
1022 Carrying Case . . . . 5 lbs

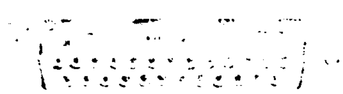
Prices and specifications subject to change without notice.

INTERFACE CABLE SELECTION GUIDE

In the majority of cases, interface is simple if your computer is equipped with: (1) an ASCII, RS232C serial interface or adapter; or (2) a TTY or 20 mA current loop connection.

From past experience we know that the Datamyte can be interfaced with about 95% of existing customer equipment, and the three configurations to the right cover most of these situations. However, we do offer several other cables to meet the requirements of more unique or uncommon situations. Call the Datamyte Sales Department for details.

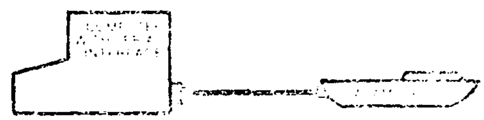
Standard 2-Row, 25-Pin Male Connector



Standard 2-Row, 25-Hole Female Connector

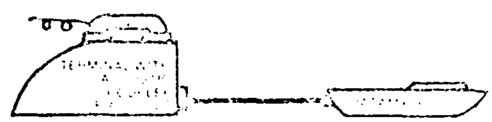
3-WAY INTERFACE (Y-CABLE #7103)

The 7103 is a universal cable used to interface the Datamyte 1000 to: (1) a terminal (CRT or printer) with an external modem, (2) a computer with an external modem, and (3) a computer with a terminal (CRT or printer). Connectors on the cable are standard 2-row, 25-pin.



2-WAY INTERFACE—MICROS AND/OR TERMINALS

The 7105 and 7106 are universal cables used to interface the Datamyte 1000 directly with most micro-computers and/or terminals. The connector on these cables is a standard 2-row, either 25-pin male (#7105) or 25-hole female (#7106).



2-WAY INTERFACE--MISCELLANEOUS

For terminals with built-in acoustic couplers, an assortment of cables is available. Some of the more commmon terminals and cables are listed below:

TERMINAL	CABLE
CDI	7106
Execuport	7106
TI-733	7109
TI-745	7105
TI-[illegible]	71[illegible]

Printed in U.S.A.

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*This and subsequent nine digit identification numbers beginning with "AD" are Defense Documentation Center identifiers.

**This and subsequent identification numbers beginning with "SLSR" are School of Systems and Logistics, AFIT, identifiers.

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